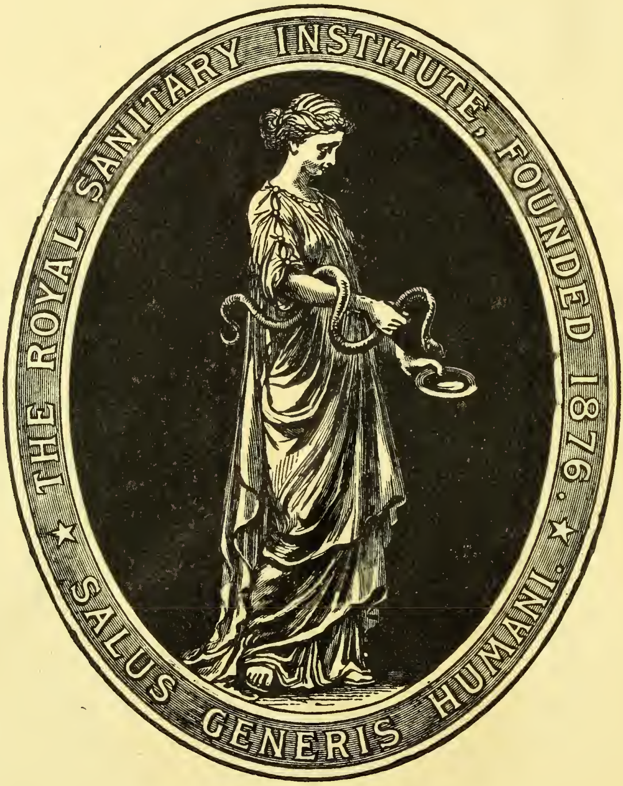
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SALUS GENERIS HUMANI.

THE PREVENTION OF DISEASE

IN

TROPICAL AND SUB-TROPICAL CAMPAIGNS

THE PREVENTION OF DISEASE IN TROPICAL AND SUB-TROPICAL CAMPAIGNS

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I Dedicate

THIS VOLUME

TO

MY FATHER.

PREFACE.

This work—adjudged the Parkes Memorial Prize for 1886—is divided into two parts. The first contains the general principles for the prevention of disease in campaigns in tropical and sub-tropical climates; in the second are developed the same principles as they concern the several special diseases affecting campaigns in hot climates. The plan of prevention has been considered throughout under certain definite heads—viz., selection of men and season, marches, clothing, food, camps, conservancy, and special prophylaxis.

In the second part, each chapter commences with a consideration of the special etiology of the disease, for unless the real etiology be known, a sound prophylaxis cannot be indicated. The greatest teachers of medicine have ever insisted on this. Thus Graves in his admirable clinical lectures states that, "it is of great importance to study how to make a man phthisical, as, by pursuing an opposite line of treatment, we may prevent it." Simon again writes: "Essentially we must know how to prevent by first having learnt exactly how to cause." I have accordingly entered fully into the various views of the etiology of the several diseases. In this respect I have not shrunk from criticizing the opinions of any authority in cases wherein, in my opinion, these views are harmful to the State. At the same time I trust I have not transgressed the bounds of fair criticism. In particular I hold the present tendency to ascribe an increasing circle of diseases to "climate" as hopeless and harmful, and unworthy of the scientific medicine of the day. Moreover, the arguments employed in support of the climatic theory of specific diseases, such as cholera and enteric fever, are singularly easy of refutation. Let any one, for instance, compare the respective Reports on the two epidemics of cholera in con-

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nection with the Hurdwar fairs of 1867 and 1879, contained in the Reports for those years of the Sanitary Commissioner with the Government of India. Both these epidemics are stated to have arisen under nearly precisely the same circumstances, yet in 1867 human intercourse was declared to have been indicated, whilst in 1879, the theory of "climate and other causes" was substituted. But the Report of 1867 is as convincing as that of 1879 is not. The great physician, in whose honour the memorial essay has been instituted, forcibly criticized the climatic theory regarding the epidemic of 1872, and exposed its fallacies. The extreme development of the climatic theory would seem to have been reached in connection with the late epidemic in Egypt, wherein it was urged that cholera nostras and cholera Asiatica are identical.

The principles of prevention of disease in tropical campaigns laid down in the following pages, are such as should be followed wherever the circumstances of any campaign permit of their adoption. It is, of course, not to be expected that such permission will in all cases be possible. But by keeping in view such measures of prevention as would be adopted, where such adoption is possible, much may be attained.

I have to thank the Committee of the Memorial Fund for permission to publish this volume. The original matter has been revised throughout.

In conclusion it may be remarked that of late years the various writings of certain authorities on sanitary science have been collected and republished to great advantage. The summaries of the late Professor Parkes on Public Health, published in the A.M.D. Reports, are unrivalled as regards the reasoning employed and literary diction. But inasmuch as papers embodied in Reports are generally consigned thereby to comparative oblivion, the republication of the writings of Professor Parkes, contained in the A.M.D. Reports, would be a work of vast benefit.

A. D.

CONTENTS.

PART I.

GENERAL PRINCIPLES.

PART II.

SPECIAL DISEASES.

ERRATUM.

Page 112, 14th line from bottom, *for* "vaccination" *read* "inoculation"; also in marginal note.

PART I.

GENERAL PRINCIPLES.

CHAPTER I.

GENERAL REMARKS.

The prevention of disease amongst troops in tropical and sub-tropical climates is a subject of the first importance to the British army, inasmuch as not only is the foreign service in peace almost entirely tropical or sub-tropical, but such will be the case in war. All our wars, in fact, since the cessation of the pre-sanitary era have been in tropical, sub-tropical, or warm climates. Moreover, it would appear that, since the year 1860, fighting has been the normal condition of the British, or Indo-British, army. With the exceptions of the years 1861, 1862, 1866, 1869, 1870, and 1881, we have been on the war-path in warm climates year after year from 1860 up to 1886. In 1870, also, we had an expedition, though not in a warm climate. This expedition, being a model expedition in a cold climate, will, however, teach us the standard to aim at; whilst we have the experience of 22 years' campaigning in tropical and sub-tropical climates to help us.

War has ever caused more invaliding and mortality by disease than by wounds. And if this has been the case in cold, how much more will it be the case in hot climates? Indeed, in many of our operations of war, disease has been our enemy, and not the mechanical offence of the foe. The operations of war in Egypt in 1882 were a striking example of operations of war against disease carried on by the surgeons of the Indian and Army Medical Services.

Statistics.—Let us see now what statistics of disease our various campaigns have furnished us with generally. Leaving out for the present the statistics of special diseases, we have the following general results:—

In the China war of 1860, with 20,433 fighting men and 25,833 camp followers, the admissions per 1000 were 2049, and the mortality 53.95. China, 1860.

In the New Zealand campaign, the seat of which in many parts lay practically in a sub-tropical region, no general statement for New Zealand, 1863-5.

disease is shown in the A.M.D. Reports, although one for wounds is given. Still we find here the usual prevalent diseases of campaigning.

Abyssinia, 1867-8. In the Abyssinian war, with a strength of 12,500 fighting men and 19,000 camp followers, the ratio of admissions was only 891.6 per 1000, with a mortality of 36.14 per 1000. There was no one killed in action, but 9.37 died from accidents; hence the actual deaths from sickness were only 26.77 per 1000.

Hazara, 1868. In the native force in Hazara for the period of hostilities, the daily sick percentage of strength was 4.20.

Looshai, 1871-2. In the Looshai expedition of 1871-2, out of an average strength of 1657.2 in the left column, there were 107 deaths; and out of an average strength of 1709.7 in the right column, there were 32 deaths.

Ashanti, 1873. In the Ashanti war of 1873, the admissions were 1700 per 1000 of strength and the deaths 31 per 1000. As compared with the former expedition in 1863, the greatest improvement is shown; for in the expedition of 1863, at one time there were actually one-fourth of the men in hospital, besides a vast number of out-patients.

Duffla, 1874-5. In the Duffla expedition of 1874-5, out of a strength of 2800 (1000 native troops, 1200 Transport Corps, 600 followers), the admissions per cent. to average strength were 50.42 and the deaths .39 for the troops; 108.15 per cent. admissions and .77 per cent. mortality to average strength for the Transport Corps.

Malay, 1875-6. From November 20, 1875, to March 27, 1876, the total admissions in the Malay war for the period were 218.71 per 1000, whilst the mortality was 21.70 per 1000. The average daily sick per 1000 was 14.82.

Galeaka-Gaika, 1877-8. For the Galeaka-Gaika campaign no statistics are given in the Medical Report for our purpose.

Jowaki, 1877-8. In the Jowaki expedition the percentage of sick was 4.35.

Affghanistan, 1878-80. The sickness and mortality in the war in Afghanistan were as follows:—For the European army: for 1878, admissions, 340.10; deaths from sickness, 2.82; deaths from injuries, 0.63. For 1879, average strength, 9500; daily sick rate, 57; admissions, 1315.50; deaths from sickness, 74.63; deaths from injuries, 13.70. In 1880, admissions, 1107.10; deaths from sickness, 30.64; deaths from violence, 6.68. For the native troops: in 1879, the average strength being 15,091, the daily sick ratio was 95.6, and the deaths were 84.95. For 1880, the daily ratio of sick was 72.6, and deaths 82.24 (ratio per 1000 of strength).

Zulu war, 1879. In the war in Zululand, out of a strength of 12,651 (non-coms. and men), the ratio of mortality per 1000 of strength was 26.63, and of invaliding 86.4, for the period from January 4 to October 3, 1879.

Natal and Transvaal, 1880-1. In the campaign in Natal and Transvaal in 1880, including all the various sieges, there was good health generally, due "to the unremitting care of the medical officers."

Egypt, 1882. In the operations of war in 1882 in Egypt, out of a force of 13,013 there were 7590 admissions in a period of 87 days, of

which 671 were for traumatic causes, leaving a disease admission ratio of 530.2 per 1000. This expanded into a ratio per annum becomes 2222 per 1000. As for the deaths, there were 170 in all, of which 98 were from battle or accidents, leaving 74 for disease, or a ratio of 5.88 per 1000 for the 87 days of the campaign, equal to 24.65 per 1000 per annum.

As regards the Indian contingent, the admissions for European troops per 1000 per annum were 1597.00; the deaths, 39.82; and for the native troops, admissions, 919.00; deaths, 11.36 per 1000 per annum.

In the Aka expedition, from December 13, 1883, to January 21, 1884, out of a strength of 30 officers, 1028 men, and 1993 camp followers, there were 4 deaths in action and 1 from disease. Aka, 1883-4.

In the expeditions in the Eastern Soudan in 1884, the admissions per 1000 were 127.42, and deaths 31.36 per 1000, out of a force of 4500 officers and men and 200 natives; or, per annum, admissions 912, and deaths 224. The mortality, be it noticed, was entirely confined to injuries; from disease it was *nil*. E. Soudan, 1884.

In the Nile expedition, out of a strength of 10,771 men of the regular army, there were 832.21 per 1000 admissions, with 51.71 per 1000 deaths. Nile expedition, 1884–5.

In the Suakim expeditionary force of 1885, the admissions were 296.6 per 1000, and deaths 14.37 per 1000. Suakim 1885.

Now these statistics show one result at any rate. They show that the preventive power of military medicine has learnt lessons from experience. In the space of 22 years, it has diminished by more than half the mortality. Let us take the 6 important campaigns in China, Abyssinia, Ashanti, Afghanistan, Zululand, and Egypt, and see the results :— Summary.

China, 1860.—*Mortality*, 53.95 per 1000 per annum. Now, even this comparatively high rate of mortality in war was an improvement on the peace year of 1859, when the death rate was 59.35 per 1000 per annum.

Abyssinia.—*Mortality*, 36.14 per 1000 per annum; but the actual deaths from sickness were only at the rate of 26.77 per 1000 per annum.

Ashanti, 1873.—*Mortality* from sickness, 31.00 per 1000 per annum.

Afghanistan, 1879.—*Mortality* from sickness, 74.63 per 1000 per annum.

Afghanistan, 1880.—*Mortality* from sickness, 30.64 per 1000 for ten months, or 36.77 per annum.

Egypt, 1882.—*Mortality* from sickness, 24.67 per 1000 per annum.

Here, then, we have, if we except the first year in Afghanistan, a surely decreasing rate of mortality from sickness in campaigns. But the campaign in Egypt showed something more. It has been ever the rule for the mortality from sickness to exceed that from wounds. But in 1882 in Egypt the mortality from wounds exceeded that from disease—a sure proof that preventive medicine did its duty.

From a consideration of these campaigns, extending nearly continuously from 1860 to 1885, we learn that the disease incidental to warfare in warm climates can be progressively diminished. It is now my task to indicate the lines on which still greater perfection may be attained. The subject naturally divides itself into two great sections: first, the prevention of disease generally; and secondly, the prevention of especial diseases. I address myself first to the prevention of disease in general.

Considerations Concerning Climate Generally. — The environment must ever be an important determining factor on individual life. And those animals that can best adapt themselves to varying conditions of the environment must possess in themselves the greatest power of healthy living and survival. And of all animals, man has the largest power of adaptation.

Trousseau's views.

I cannot do better than quote Trousseau on this point: "Man is unquestionably the animal capable of becoming most easily adapted to diversities in the external circumstances necessary for maintaining life. The first individual of our species did not assuredly come into existence in latitude 50°: his body not being protected by hair or feathers, like other animals of the higher classes, proves that the Creator called him into being in a climate sufficiently mild to enable him to dispense with clothes, which in our climate are absolute necessities. However, the territory of man's origin becoming overcrowded, emigration took place to other regions. Crossing the surface of the globe from North to South, from East to West, everywhere adapting itself to new climatological conditions, the human race became able at last to live as well in polar as in equatorial regions. This adaptation, however, to the greatest possible diversity of climate is perhaps less remarkable than the adaptation of man to great diversity of food. Advancing from the simplest possible regimen, consisting principally of slender rations of vegetables, such as rice, with water and a little milk to drink, a regimen similar to that which the Indians and other peoples still subsist on, man has reached that generous fare of northern nations which contains so large a proportion of animal food. His organization has become habituated to conditions totally different from those in which he was originally placed; it has well adapted itself to them, and has by means of the new regimen made the man of the North a much more vigorous man than the man of the Equator."

I have quoted this passage at length, as it admirably expresses the adaptation of man to different climates. And moreover it shows that such adaptation was brought about by certain changes in the food and dress of man. Finally, the passage terminates with a warning that the man of the North has become more vigorous than the man of the Equator. Must, therefore, the man of the North in retracing his steps become less vigorous? This is the problem, indeed, that the preventive medicine of war in hot climates has to solve. Meanwhile, at its inception the man of the North starts with certain points in his favour: first, the greater vigour of northern races has been attained only through a long

series of years, and hence *for a comparatively short period*, such as that of a campaign, we should be able to prevent much deterioration of this vigour; and, secondly, the races indigenous to temperate climates have been found to possess a greater constitutional pliability, enabling them the better to support the extremes of other latitudes. And, in addition, the northern *soldier* should benefit from these two factors especially, inasmuch as he should be a picked man. From this passage of Trousseau, then, we gather certain lines to work on in the matter of selection of material, of clothing such material, and of feeding such material.

Sir R. Martin's views.

This superior adaptability has, however, been questioned by Sir Ranald Martin. He denies the superior power of accommodation to all climates in man, stating that the real factor is the greater ingenuity of man mentally, whereby "he can raise up a thousand barriers around to obviate the deleterious effects of climates." This opinion I venture to think is erroneous, as I shall show presently; meanwhile, from *à priori* considerations it would seem incorrect, for inasmuch as man is superior to the lower animals in all respects, so he must have a greater latitude of adaptability.

Robert Jackson's views.

One of the greatest of army physicians—Robert Jackson—has placed it on record that men in hot climates could work as well as they do in cold climates. Now, from a consideration of the views of these authorities, it is evident that the army surgeon in hot climates can have no ground for taking refuge in "climate" when confronted with disease; for on the one hand he has an extremely adaptable and picked material to work with, and on the other, whether by means of "a thousand barriers" or otherwise, such material can be kept flourishing in hot climates for *a certain period* of time.

Nature of Hot Climates.—Before proceeding to point to the essential modifying factors in climate, it will be well to examine examples of hot climates such as our troops have encountered. The climate of China for a part of the year was found characterized by extreme vicissitudes. Thus, in September the temperature would be 142° F. in the sun at noon, but at night would fall to 49° F., thus giving a variation of nearly 100° F. in the 24 hours. In Abyssinia the days were tropical, but the nights "Siberian;" but owing to the *dry* condition of the atmosphere the general health was not so affected as it otherwise would have been. In the Looshai country, the hill-sides were covered with masses of vegetation to their summits. Tortuous ravines intervened, their hollows swampy, and with an impenetrable matted jungle of forest trees, bamboos, and creepers. Till late in the day this sea of jungle is shrouded in a mass of vapour, and the dew pours from the trees like heavy rain (Dr. Buckle). A very similar climate was found in the Duffla country. In Malay again we find another moist climate: a variable wind, veering to all the points of the compass in 24 hours: drenching showers of rain—morning and evening chilly, but a very offensive heat at noonday, the temperature continuing high till evening. In Ashanti the climate again is very similar to that in Duffla and

Looshai. Here, therefore, we have vicissitudes of temperature with a *moist* atmosphere.

Look again at the shores of the Persian Gulf. Here the summer heats are terrific; by some the littoral is held to be the hottest part of the known world: the summer heats "are fierce beyond endurance." Moreover, the heat is a moist heat, and therefore, the more depressing. In addition, a hot wind, raging in July and August, blows for nine months in the year. But in December and January the opposite condition prevails, for we have then cold piercing winds from the interior.

Again, the semi-tropical climate of Algeria is characterized by great heat, and rapidity of change to cold. There is the greatest difference between the day and night temperature, especially inland. Many more examples might be added, but enough has been given to show what a change such climates must be to the soldier coming from northern latitudes. England, for instance, has an equable climate; in all the examples given we have seen the greatest vicissitudes of temperature. Now, equable climates, whether hot or cold, are more favourable to human life than those subject to great diurnal or annual fluctuations. Here, therefore, we see one element in climate to provide for—viz., alteration of temperature—and naturally the mind turns to the material of the dress. Again, every climate has a period when its features are less unfavourable to life—a period, in fact, in which there is a comparative equability; such must be the period for selection for warfare, as we shall see hereafter.

Factors of climate.

We are now, after this brief summary of the characteristics of climate in certain hot regions, in a position to enter fully into the chief factors of a hot climate which especially influence the health of the human element. Now, under the term climate we understand the combined effect of temperature, air pressure, moisture, wind, and electrical phenomena of any portion of the globe. According to the nature of the combination is the suitability of various districts for the support of their respective fauna and flora. Now, as regards the tropics, the two great determining factors of climate in disease are, without doubt, the temperature and the rainfall.

Division of climate.

The earth was long ago divided into zones: thus Parmenides made three zones, the Torrid, Temperate, and Frigid, and taught that the only habitable region was the Temperate. Rochard expanded the number of zones again into: (1) the Torrid, from the thermal equator to the isothermal line 77° F.; (2) the Warm, from 77° F. to the isotherm 59° F.; (3) the Temperate, from 59° F. to 41° F.; (4) the Cold, from 41° F. to 23° F.; and (5) the Polar, 23° F. to 5° F. Now, the factor temperature rests its influence on animals, not merely as regards its absolute degree of heat, but as regards its *variability*. The variations in temperature are, indeed, of far more importance to the organism than the absolute degree of heat. A constant high temperature is much healthier than a variation between two extremes lying far apart. Karl Semper points out that isothermal lines are not of much value in judging of climate; "the mean temperature of any day,

Effect of a rising temperature.

assumed as the basis of the curves, can afford no standard by which to measure the influence of the heat during that day, since the mean may be the result of very different extremes." For every animal there is a certain degree of heat—the optimum —which is most favourable for the well-being of that animal, and every change of temperature above or below this must be, to a certain extent, injurious to it. Hence, in considering the factor of temperature in the tropics and sub-tropics, we can more rationally do so by leaving out of consideration the zones both of temperature and of latitude. *The effect of temperature of warm and hot climates is, in fact, the effect of the rise of temperature above the temperature optimum of the particular animal.* Fortunately, as we have seen, the human species of northern latitudes can best endure great variations in temperature. With regard to this endurance of variations from the optimum, animals have been divided by Mobius into those capable of endurance of great variations, eury-thermal, and those incapable of such, or steno-thermal. Man, and especially the man of northern latitudes, is eury-thermal. The effect of a rising temperature on animal life is to stimulate all the vital functions of every living animal up to the point of the optimum, at which point the functions are at their highest efficiency. But if the temperature rises above the optimum, the reverse sets in: the functional activity is reversed and reduced; thus at first most Europeans become indolently inclined under the heat of the tropics. This reduction may go on with increasing heat, until heat coma and death supervene. Moreover, the injurious effect of too great heat is permanent; the effect of a reduction of temperature below the optimum need not be permanent, for vitality may become latent, but this is not the case with heat. Thus, then, as far as the factor of a high temperature is concerned, we have to deal with it, first, as regards the variation from such a temperature to lower degrees; and secondly, as regards progress in elevation. We have, in fact, to counteract the effect of variations from the optimum, and continual rise above the optimum.

The second great factor in climate is humidity. The supply of moisture, both as regards its total amount and its seasonal distribution, is of the utmost importance. As a rule, the lighter the rains the less the sickness. The first Burmese war gave a terrible example of campaigning during the rains. Provided the air is dry, tropical heat can be endured with health. Years of drought have been years of health. Moisture, especially in a hot climate, aids putrefaction, and, in the absence of good conservancy, "putrefaction of all kinds is apt to run riot and zymotic disease to spread." The influence, moreover, of the rainfall on malaria, enteric fever, cholera, yellow fever, &c., is great, as will be pointed out in the following chapters. Rainfall. Humidity.

From the foregoing considerations of the action of the two great factors in climate, we gather, in planning a campaign in the tropics or sub-tropics, *selection of season* must be calculated for. And we further see that the hot and rainy seasons are to be avoided. Summary.

Nosology.—But there is another factor yet to be considered, and that is the distribution of disease. In like manner as there are fauna and flora proper to the tropics, so are there diseases. Dr. Munro and others speak of the direct influence of heat in its various degrees acting on moisture, and so causing various tropical diseases. They hold that malarial fevers, yellow fever, and cholera, &c., are but manifestations of the effect of different degrees of heat due to different degrees of paralysis of the sympathetic. This theory of the relation of disease to heat is utterly incomprehensible, it is true; but, nevertheless, it points out that there is a mutual relation between disease and temperature. Now, as Herschel has pointed out, we pass through the same series of climates, as far as temperature is concerned, when we ascend a mountain from the sea-level to the level of perpetual snow, as we should do by travelling from the same station to the Poles; and we find, according to the altitude of any spot, the different varieties of climate characterized by the flora appropriate to the habitual temperature of that spot. Substitute disease for flora, and the same remarks hold good. Dr. Fergusson, who accompanied the expedition to St. Domingo in 1796, wrote: "Our head-quarters were in the town and its adjunct, Brizoton, as pestiferous as any in the world; and here we had constant yellow fever in all its fury. At the distance of a mile or two on the ascent up the country stood our first post, Torgeau, where the yellow fever appeared to break off into a milder type of remittent. Higher up was the post of Grenier, where remittent fever was rare, and intermittent and dysentery prevailed; and higher still was Fourmier, where remittent fever was unknown, intermittent uncommon, but phagedænic ulcers so common as to constitute a most formidable type of disease; and higher still were the mountains above l'Arkahaye, where a British detachment had always enjoyed absolute European health. Here were the separate regions or zones of inter-tropical health mapped out to our view as distinctly as if they had been done by a draughtsman. Taking Port-au-Prince for the point of departure, we could pass from one station to another, and with a thermometer might have accurately noted the locale of diseases according to the descending scales, without asking a question amongst the troops who held the posts." Now, as regards climate, latitude is of more importance than longitude, although both exert an influence on the type of disease. Diseases, in truth, as Muhry states, have not been thrown haphazard over the face of the earth. Each country has its distinctive diseases, for diseases, like plants and animals, can only flourish within certain geographical limits. Such being the case, it is important for the army surgeon, about to embark on any campaign in hot climates, to know the nature of the diseases he will meet, in order that he may take the necessary means to prevent them. Aitken, in a most interesting chapter, has stated the known facts of the geographical distribution of disease; and he has moreover shown, not only the relation of the diseases met with to *temperature and moisture*, but also the fact

that they are *mostly of a communicable type.* Humboldt's isothermic line of 77° both north and south of the Equator marks out the region of the tropic zone as regards temperature. The sub-torrid zone is included in the adjacent temperate. In the tropic isothermic zone we have China, Malay, India, Afghanistan, Persia, Arabia, Abyssinia, the Soudan, Ashanti, Mexico, North Australia. Within these limits of temperature the British army has fought the campaigns of China, Abyssinia, Looshai, Ashanti, Sunghie-ujong, Malay, Duffla, Afghanistan, Egypt, Soudan, and Aka. And, finally, within these limits are to be found the worst forms of malaria, bowel affections, cholera, yellow fever, simple fevers, ophthalmia, beri-beri, guinea-worm, filaria sanguinis hominis, enteric fever, typhus, relapsing fever, &c. And, moreover, the higher the temperature the greater is the rate for malaria, bowel complaints, yellow fever. Lastly, as we merge into the subtropics, we find the continued forms of fever giving place to intermittent. This relation of temperature to disease has lately been brought out as regards pneumonia by Dr. Sanders, of the United States, in a most complete and thorough manner, completely upsetting our preconceived notions. Now, the geographical distribution of disease must perforce be a most important element in campaigning; but, by knowing what to expect, we are in a certain measure fore-armed. Nevertheless, although there is this undoubted geographical distribution of disease, yet it is important to remember that, so far from being unable to cope with it, we can act in antagonism to it. Take the class of bowel complaints: by ensuring wholesome food, solid and liquid, we can remove all causes of irritation from within; by ensuring a rational dress, we can remove irritation from without. Again, in the matter of conservancy, by ensuring the absence of putrefaction from the camp, and the burning or disinfection of excreta, we cut the ground away from the feet of cholera, enteric fever, yellow fever, and bowel complaints. The Army Sanitary Commission relative to the rate of invaliding in Madras distinctly states, in its memorandum of March 13, 1880, that much of the loss from invaliding in Indian climates is due to the continued action of eating, drinking, and clothing *directly opposed to the requirements of the climate.* In every one of these particulars improvement can be made.

Finally, with regard to the nosological element, it must be borne in mind that all diseases, however trivial otherwise, become serious in the tropics.

Fatigue. Insufficient nourishment.

I have now considered the factors of temperature and moisture, and the factor of nosology as applied to hot climates. There are two remaining great elements—viz., fatigue and insufficient nourishment—to guard against. In has been indeed held that climate *per se* is secondary to these; doubtless, as regards temperature and moisture, this is the case, for if a man be properly fed, and not overworked—that is, if his mechanical work be proportioned to his individual powers, and his food in accordance with his proportioned work—the factors of temperature and

moisture will have but little power on him except in extreme instances. And as regards nosology, it is obvious that a man thus fed and worked will not be predisposed to disease. For the effect of labour, if duly proportioned, is antagonistic to disease. In the New Zealand war, the good effect of such hard work under heat and a varying climate was well shown in the force engaged in road-making from Auckland to Waikato—the hottest part of the island.

I have now alluded to the analytical elements affecting hot climates as regards temperature, moisture, nosology, fatigue, and insufficient nourishment. To enable us to draw conclusions as to the actual action of such climates in campaigns, a few examples of military life in certain regions will be briefly commented upon.

Sierra Leone.—The early history of Sierra Leone is very instructive. The quarters were on a bad site, surrounded by forests and underwood, the annual decay of which was fertile in producing malaria. The men garrisoning the station were desperate men in many cases, and notoriously careless of life. They indulged in vinous and sexual dissipation; kept late hours; were careless of personal cleanliness, and of exposure to the sun. Their food was largely of salt meat, monotonous in its want of variation. Finally, exercise could only with difficulty be indulged in. No wonder, then, the mortality was excessive. But the mortality was excessive, *not* from the climate, but from the habits of the garrison and their environment. The early history of this station teaches us that, to avoid such results, our men must be camped on properly prepared soil; must have a varied diet; must be strictly temperate; must avoid all sun exposure in the hot hours of the day; and must take regular exercise.

French in Algeria.—Study again the history of the French in Algeria. Our last example was an example of life in hot climates in peace. I now proceed to give an example of life in hot climates in the varied conditions of peace and war. Now, the death rate in the Algerian hospitals for the first five years succeeding the conquest was 79 per 1000 per annum! Then from 1837 to 1846 it stood at 77.8 per 1000 per annum; in 1847 at 30.79 per 1000; in 1848 at 35.77. From 1848 to 1858 no statistics are obtainable. In 1859 it was 56.7 per 1000; 1860 at 17.8; 1861 at 11.3; 1862 at 12.21; 1863 at 12.29; and 1864 at 21.25 per 1000 per annum. The year 1864 was, however, one of military operations, and, if the number of those killed in action be deducted, the mortality will be 14.48. The slight addition then shown can be explained by the increase of disease causes incidental to a campaign.

Now, the diseases met with in order of frequency were dysentery, diarrhœa, pernicious malarial fever, typhoid, pneumonia, undefined fevers, pulmonary consumption, cerebro-spinal meningitis, small-pox, hepatitis, and bronchitis.

A commission was appointed to examine the whole question, and the conclusions arrived at were that the large death rate during the early years was due to the malaria, unhealthy

localities of camps, want of shelter, insufficient rations and clothing, harassing nature of service in constant expeditions, exposure to a strange climate, and want of knowledge of the habits required by that climate. The improved health in the later years arose, on the contrary, from the conquest and subsequent colonizing and works of agriculture in the country; the draining of unhealthy localities, and precaution in turning up new ground; the increased facility for obtaining supplies, and consequently better rations; better cooking; improvement in dress, and the use of flannel belts; and the use of the *tente d'abri* in bivouacs. Finally, in the employment of quinine as an antiperiodic ration. The health of the French army in Algeria has, through hygienic principles, so progressively improved that the mortality there now is very little higher than that of the troops serving in France. In the list of diseases it should be noticed that hepatitis occupies the lowest place but one; in the same year, however, in Bengal, it occupied a position next to cholera. In accounting for this difference it is to be noted that the French soldier drinks very little spirit with his rations. Here again, then, we learn that the factors of disease in hot climates are related chiefly to the conditions of camps, dress, food, exposure, and habits generally of those who live in such climates.

The Disastrous Russian Campaign against the Turcomans in 1879.—I will now consider the matter entirely in its war aspect. The Russian campaign against the Turcomans will teach us still further lessons in prevention. Notwithstanding the men employed were the picked troops of the Caucasus, and notwithstanding that the man who commanded them was a born leader of men, of superhuman energy, yet disease carried off in vast numbers the troops, whilst General Lazareff himself succumbed to an affection evidently the result of the environment.

In the first place, owing to the want of necessary foresight and preparation, transport was not ready. Originally, May 10 was fixed for the advance of the troops; if this had been carried out, the men would have escaped the torrid heat of a summer march across the sandy desert; as it was, the advance guard was delayed by want of transport for forty days, and "five precious weeks of spring irretrievably lost." On June 18 the advance guard set out, but the main body of the troops were still kept rooted at Tchikishlar on the Caspian for the same want of transport. "Throughout the hot and feverish month of July the troops remained at Tchikishlar awaiting the arrival of the camels which never came." And what a camp it was! During the two summer months after the departure of the advance guard the camp burnt like a furnace. The rays reflected from the sand were scorching. The health, which on disembarking from the Caucasus had been at first good, soon began to deteriorate. Under the use of impure water, when pure might have been obtained, exposed to the tropical heat and miasma amidst the "nauseous negligence" of the camp, the troops sickened and died.

The days were very hot (113° F.), the nights very cold. Ophthalmia, scurvy, dysentery appeared, the latter so severely that 25 per cent. of the sufferers died. There was a total absence of vegetables in the rations. "Epidemic disease of every description raged."

On August 11, at length, the army began to march for the enemy. But now the marches were terrible. As soon as the sun rose, the heat felt like that from "a brazier of burning coals" held close to the face. The direct rays of the sun were further aggravated by the horrible burning dust rising from the ground. Arrived at Tchat, the temperature was found to be 150°. The water again was bad. Such were the conditions that it was said the very devil himself would burn at Tchat; whilst the men, greeting one another, would say, "How do you feel in your stomach to-day?" Sunstroke and dysentery were of every-day occurrence. At length, worn out by his exertions, Lazareff died in a few days from blood-poisoning from a carbuncle. The subsequent history of the expedition need not detain us. But we here see how all this disease was owing to those who planned it. The men, indeed, were picked men; the general was a picked man. But, owing to the absence of transport, the cool season of the year was lost; owing to the absence of iron tubes, the impure surface water had to be drunk for many months, until tubes were sent; owing to the absence of vegetables, scurvy raged; owing to the absence of spectacles, ophthalmia was rife; and owing to the absence of a proper covering to the head and of spectacles for the eyes, sunstroke found its victims. Added to all, there was a total want of conservancy in the camps.

The Ashanti Campaigns of 1863 and 1873.—In 1862 a quarrel occurred between the Ashantis and the tribes under British protection. A small force sent under Major Cochrane having failed sufficiently to chastise the Ashantis, it was determined in 1863 to proceed against them with a larger expedition.

In 1863.

The preparation for the campaign, however, consumed the cold weather up to December 1863. On December 27 an advance was made to Mansu, 40 miles from Cape Coast Castle. Prahsu, 45 miles from Mansu, was reached on January 27. After reaching Prahsu, five weeks were occupied in clearing the bush and hutting the men. Coomassie was still 85 miles off at the end of February. On March 1 the rains set in. The constant toil in the excessive heat of the swampy forest, and the drenching rains, soon caused inordinate sickness. The heat was excessive by day, and succeeded by damp and chills and fogs at night. On March 31 there were 90 men in hospital out of an entire force of 360! Besides these, a large number were out-patients, there being no hospital accommodation. On April 9 reinforcements arrived at the base, and arrangements were made to bring down half the troops from the Prah. By May 14 all the troops who had gone up first had been relieved by new arrivals. But the newly arrived troops suffered even more than the relieved troops from the prevailing fever and dysentery. Early in June half

the detachment at Prahsu were sick, and on June 18 it was determined to give up the expedition and bring back the troops.

In 1873 we were again engaged in hostilities with the Ashantis. In 1873. Before the arrival of Sir Garnet Wolseley there was again great sickness during the rainy and hot seasons at the coast. The mortality amongst the Marines exceeded even that of Walcheren, being 17.30 of strength disembarked, against 17.04 at Walcheren. At Cape Coast Castle the greatest neglect of sanitation was regnant. Unventilated, overcrowded, closely packed buildings; refuse of all kinds, and ordure, in unscavengered streets lying exposed to a tropical sun; and stagnating drainage—such were the forcing-beds lying at hand for tropical diseases. With the remembrance of the abortive expedition of 1863 at hand, it had been seriously debated whether white troops could campaign on the Gold Coast. The line of argument adopted by Sir Anthony Home, V.C., the principal medical officer of the force, furnishes an epitome of the essentials for tropical campaigns, and, as such, is worthy of being reproduced here. Now, against the employment of white troops were such facts as the proverbial unhealthiness of the region; the history of the Royal African Regiment, who had a mortality of 98 per cent. in 1834; and the abortive expedition of 1863–4. But, on the other hand, Dr. Home contended that, as regards the Royal African Regiment, the men were hopeless and reckless, living in barracks devoid of proper cubic space and ventilation, clothed in unsuitable dress, fed for a whole year without one single fresh-meat ration, with scarce and indifferent vegetables, and on water exceedingly unwholesome. Not that the men indeed apparently drank much water, for their alcoholic excesses "baffled description." And again, those who drank least suffered least from disease. As regards, moreover, the expedition of 1864, the general nonconformity of the environment to the character of the expedition, and its prolongation into the rainy season, was pointed out.

As regards the advisability of employing white troops, it was further urged that there was a season of comparative healthiness at Cape Coast, and that it was probable that the country would become healthier as the coast was left behind. Moreover, the troops were selected, and were properly equipped and fed. The health of the European officers who had already been for two months in the region had not been disastrously bad, and, moreover, Europeans had previously campaigned with success in low-lying tropical climates.

As the results of such argument and such preparation, European troops were employed. The result speaks for itself. We have seen that the mortality of the Marines, who had been sent home earlier, reached to 17.30 per cent. of strength disembarked. The mortality of Sir Garnet's force of strength disembarked was 3.14 per cent., or 14.16 per cent. less.

Egypt, 1801, 1882.—There is much similitude between our war in Egypt in 1801–2 and our operations of war in Egypt in 1882. In both, two forces were employed—a force from Europe

and a force from India. And in both, military medicine shewed brilliant results in prevention.

1801. On January 1, 1801, the European force was mustered at Aboukir Bay. On March 8, 12,000 fighting men were landed and won the battle of Aboukir; on the 21st we won the battle of Alexandria; on September 1 Alexandria surrendered. The sick list was as follows, after seven months' active operations:—First, a sick list of 102 per 1000 at Marmorice Bay, increased to 110 per 1000 prior to the landing at Aboukir Bay; further increase to 276 per 1000 after the battle of Aboukir and the battle of Alexandria; and finally falling to 251 per 1000 at the end of the campaign.

The Indian contingent landed at Cossir, on the Red Sea, too late for any fighting, except against disease. Early in June 1801 the troops were all assembled there, and were "uncommonly healthy." This healthy condition was due to the wise sanitary measures during their long confinement for six months on the transports, the transports being healthy and roomy, the men selected, supplied with good water, fresh provisions, and vegetables, whilst good sanitary regulations were rigidly enforced.

On crossing the desert the clothing and diet were admirably arranged for; so much so that they reached the Nile with only some few cases of diarrhœa and ophthalmia. During the greater part of July the army lay on the banks of the Nile, but at the end of the month they embarked, and at the end of August arrived at Ghiza, "with only a few cases of slight fever." Now, however, the men began to suffer much from sickness, especially fever, ophthalmia, hepatitis, and dysentery. On September 14 the first case of plague was diagnosed, and cases came in for some time; nevertheless, the disease was well held in check, so much so that the native troops, who began by abandoning themselves in despair, ended by furnishing volunteers for the pest-house. All the Indian contingent were at Alexandria in January 1802. In May 1802 they recrossed the desert, and early in June embarked for India, with the exception of one regiment, in which the plague still prevailed. Among those that thus embarked there was hardly a sick man; in the regiment left behind, after the plague left it there were only four sick of colds prior to its embarkation. Finally, all the troops arrived healthy in India. Now, as regards the sick list for the Indian contingent, the death rate from the time of embarkation for Egypt until their re-arrival in India was 82 per 1000 for the European and 95 per 1000 for the native soldiers. Reducing these to the standard of a year, the death rate for the Europeans (who were on service rather more than nine months) was 109 per 1000 per annum; for the natives (who were on service nineteen months), 60 per 1000 per annum.

These results were considered at the time to be very excellent. Had it not been for the plague, they would have been still more so. The provisions made for the Indian contingent were certainly in advance of the times.

But excellent as the results were held to be at that era, they were altogether eclipsed by the results in 1882. Here, as we have seen, the admission for disease for the European force was at the rate of 24.67 per 1000 per annum. This cannot be accurately contrasted with the European force of 1801, as the calculations are based differently. But, as regards the rates for the Indian contingent of 1882, the deaths for European troops were at the rate of 39.82 per 1000 per annum, and of 11.36 per 1000 per annum for native troops. The following table will show the difference at a glance in the results of 1801–2 and 1882—

European troops,	1801,	Mortality per 1000 per annum,	109.00
,, ,,	1882,	,, ,, ,,	39.82
Native troops,	1801,	,, ,, ,,	60.00
,, ,,	1882,	,, ,, ,,	11.36

So much, then, for the progressive results of preventive military medicine. Two more facts in conclusion must be mentioned as regards the expedition of 1882: (1) For the first time in the history of the world, a campaign was fought without a single case of so-called hospital disease; and (2) "Not a single soldier died of disease brought on *by climate* or natural causes" between the date of general landing and the date of re-embarkation for India.

From the foregoing sketches we are by degrees brought up to the great fact that a campaign can be conducted in a hot climate without the occurrence of disease brought on by "climate." Such, we see, was the case in the Indian contingent in 1882. And here, be it remembered, there was no selection of season; the campaign was not fought in the most favourable period of the year. Results of these campaigns.

Action of Climate.—What, then, is the action of "climate" *per se* in hot climates? Within a measurable limit as a primary factor, *nil*. A prolonged residence in a hot climate doubtless deteriorates the system. It is the duration of heat, and not the intensity, that is the determining cause of such deterioration. The energy of Englishmen who have been long residents in the tropics lessens. Again, natives in hot climates are very sensitive to variations of temperature, and, after a time, Europeans become so too. But, as regards tropical campaigns, the element of time is on the side of the European, for, if short, the period will not be long enough for him to be seriously affected. By proper selection of men and season, by reasonable food and clothing, "climate" may be located to a secondary place. And as regards the influence of "climate" as a direct etiological factor of cholera and enteric fever, I hold that to suppose such a causation is as dangerous in practice as it is baseless in fact.

The late Tonquin expedition illustrates the above assertions. The mail of September 10, 1885, stated that, in the French hospitals at Tonquin, there were 3000 sick, and that since the beginning of the campaign the mortality had been 15,000. But in the telegraphic news of September 25 it was stated that "the

provisions are infamous, and the men's clothing rotten." The officers and crew of a ship at Chefoo were "suffering from dysentery brought on by bad meat." Now, after these items of news we read: "*The French in Tonquin are quite unequal to the climate.*" But here the "climate" is grossly libelled, for with rotten clothes, infamous and dysentery-producing provisions, any troops in the most favoured climate of the temperate zone would become unequal to the climate. Again, a leading paper stated as follows:—"The correspondent of an Anglo-Chinese paper throws some light on the inner history of the French campaign in Tonquin and Formosa. The expedition to Tonquin was neglected in a way that was criminal and treasonous. The men were sent out by driblets. The soldiers came out badly equipped, utterly unprovided for a campaign in a hot, humid, malarious, and deadly climate. For such a campaign transport should have been plentiful; now, transport was always deficient. For such a campaign the hospital service should have been on a large scale; the hospital accommodate was shamefully inadequate. The provisioning was bad. The French troops were often a fortnight without meat, wine, or bread. They had for clothing the kepi, blue cloth coat, scarlet breeches, just as if in camp at Chalons." No wonder the climate was deadly.

Sir Ranald Martin denied, as we have seen, the superior power of adaptation to varieties of climate to be possessed by man; but I cannot help agreeing with those who, on the contrary, maintain that "the power possessed by the human body of withstanding the extremes of cold and heat is, so far as climatic temperature is concerned, unlimited."

To show how a hot climate really influences mortality, it is interesting to compare the death rates of Calcutta, Bombay, and Madras with those of the chief European cities. The ratios given in the table at the top of p. 17 are taken from the Registrar-General's Reports for 1887, from April 16 to August 27, a period covering much of the unhealthy season of India. They show the comparative mortality of towns in a hot climate with those in the temperate zone in the hottest part of the year and rainy season, and we see that, so far from the hot climate exercising a baneful influence, as a rule the mortality in Calcutta, Bombay, and Madras is less than it is in European towns. But, turning to campaigns, troops can even have a lower ratio of daily sick in the field than in cantonment. Thus, in 1879 and 1880, although the mortality was higher, yet the daily sick rate was lower as regards the European troops in Afghanistan.

	Daily Sick Rate in Cantonments.		Daily Sick Rate in the Field.
1879	82	...	57
1880	75	...	65

These statistics are those of the European army of Bengal; but a similar result is shown for the whole European army in India.

Mortality per 1000.

For Week ending	Three Chief Indian Cities.	Highest English.	Nine German and Austrian Cities.	Three Chief Italian Cities.	St. Petersburg.	Number of English Towns above Chief Cities of India.	Number of European Towns above Chief Cities of India.
April 16	28.9	35.3	26.4	36.9	34.6	2	7
,, 23	28.1	36.4	27.2	33.9	33.6	2	8
,, 30	28.3	35.4	28.4	31.5	33.7	3	5
May 7	25.3	34.2	27.7	31.4	38.7	8	10
,, 14	24.3*	29.0	27.6	32.0	36.1	7‡	14‡
,, 21	22.0†	31.1	27.2	—	33.7	9§	13§
,, 28	29.0	32.3	26.4	28.3	34.1	2	4
June 4	27.9	30.5	26.7	29.5	30.4	1	4
,, 11	28.0	29.4	25.2	—	28.3	2	4
,, 18	30.0	28.5	26.3	—	29.4	0	2
,, 25	27.3	30.1	26.1	29.0	27.5	2	7
July 2	24.1	29.2	24.8	26.2	30.3	4	6
,, 9	30.8	32.1	25.1	25.9	26.5	7	6
,, 16	26.7	31.1	26.4	—	27.7	2	3
,, 23	20.0*	36.7	26.8	22.6	23.2	13‡	11‡
,, 30	—	30.1	29.0	—	—	—	—
Aug. 6	23.3*	39.3	30.8	—	25.0	14‡	11‡
,, 13	25.5	31.4	33.0	27.0	26.6	8	4
,, 20	22.6*	32.5	31.0	—	24.7	15‡	12‡
,, 27	23.9*	38.8	28.8	25.0	24.1	8‡	5‡

* Bombay only. † Calcutta only. ‡ Above Bombay. § Above Calcutta.

Dr. Dickson, late of the Royal Navy, in an interesting review of the conditions found in all kinds of climate as he had experienced them throughout a long service, stated "that a high average of health and efficiency can be maintained by Europeans *for a time* in every kind of geographical position." At all events he affirms that "on board ship from the Pole to the Equator there need not be a greater ratio of sickness and mortality than in one's own country, provided hygienic principles be carefully applied in the important matters of air, water, food, clothing, exercise, and rest." Dr. Rennie well remarked, as the result of his observations on the China war, that the conclusion was inevitable that a vast amount of mortality and disease has been attributed to climate which is in reality rather the result of defective hygiene. He found in active operation every one of those sanitary defects which, a few years before, were brought under public notice by the Army Sanitary Commission as having exercised a destructive influence on the health of the British soldiers serving in England. Again, Dr. Robert Jackson held that, with proper precautions, the troops in the West Indies could be kept healthy. Hygiene, in fact, will deprive tropical climates of their lethal weapons. We can actually prevent the special diseases of the tropics, or, rather, it is my opinion that all the special diseases to be afterwards mentioned are preventable diseases. If so, we have left only the fact that our men are in the tropics acting under a temperature which is not their "optimum." The army

physician has, then, a second object to aim at—to restrain the increment of temperature above the "optimum."

The aim and scope of preventive medicine in hot climates.

We cannot, indeed, hope that the "optimum" of the European will become so adapted to the environment of the tropics as to become raised, but we can, at any rate, neutralize to a great measure, if not entirely, the effects of this rise of temperature of the environment.

To accomplish these results, the following must be the procedure:—

A. *The instrument* is the army surgeon. Now, with regard to the maintaining of the efficiency of fleets and armies by the prevention of disease, "the medical officer should, in the first place, be not only conversant with sanitary science, but with the mode of its application to the preservation of health under every possible variety of circumstance and character." And not only this, but he must be acquainted with geographical nosology. Thus, on starting for any expedition, the "medical constitution" of the theatre of operations must be studied in its "pathological, telluric, and climateric" relations.

B. *The material* is the soldier. This material must be a selected material to begin with. The army surgeon starts with good material in the shape of a body of men in the prime of life and of sound constitution, and in such a condition it behoves him to keep it. Much must perforce be done by the soldier himself at home to keep his body sound, and to aid in this Dr. Michaelis, of Innsbrück, would have the men briefly instructed in the elementary principles of hygiene. The material from the very commencement of service must be held in hand with a view to campaigning first, and to campaigning in hot climates next. It should in peace time have a considerable period of training in camp, in foraging, cooking, marching, &c., for we have to fit our men for a twofold environment—viz., campaigning *per se*, and campaigning in hot climates. Then, on the outbreak of war, the main question of prevention will be found to resolve itself under the following heads:—

1. Selection of men, including acclimatization.
2. Selection of season.
3. Selection of transport ships.
4. Dress and bedding.
5. The nature of the camp: its site, ventilation, &c.
6. Questions relating to marches.
7. Food in relation—(1) to work; (2) to hot climates.
8. Night duties; bivouacs.
9. Questions relating to camp followers.
10. Conservancy and disinfection.
11. The hygiene of the battle-field.
12. The hygiene of beleagured posts.
13. The etiology of army diseases, and their prevention.

I propose first, then, to indicate the steps to be taken to procure a healthy environment to the soldier. I shall then enter into the etiology and prevention of the chief diseases affect-

ing hot regions. Before proceeding to the general question of selection and environment at the outset, a few remarks may be made on the nature of those diseases incidental to tropical campaigns. They have certain features which strike the observer at once. First, they are all eminently preventable; secondly, a large proportion of them are propagated by human intercourse; thirdly, in the absence of sanitary measures they are apt to take on an epidemic form; and lastly, a large number of them are probably due to a living organism.

Nature of tropical diseases.

We have thus, to start with, ground to act on; for (1) in the first group, purely preventable, but not propagated by human intercourse, we have but to study the conditions of the life-history of the disease in order to see what is necessary to annihilate these conditions. Such will be shown to be the line of prevention in malaria. (2) In the group directly contagious, we have to prevent human intercourse, and at the same time act on the conditions of life of the ferment. Again, in the group (3), infectious as distinguished from contagious, answering in a measure to the miasmatic-contagious group of the German schools, we have also to prevent human intercourse, inasmuch as it acts indirectly, so to speak, by carrying the poison in the intestinal discharges. Here we have to act on these discharges. This class, moreover, is by some held also to spread by direct personal communication. Looking, however, to diseases of campaigns in hot climates as a whole, we find two broad indications writ in unmistakable type—viz., 1. *To disinfect:* that is, to act against and annihilate the poison; and 2. *To prevent human intercourse with the sick.*

The Germ Theory.—The history of the diseases I shall treat of is intimately bound up with the grand discoveries of recent years. These discoveries, moreover, have opened to us a vista of preventive treatment undreamt of not many years ago. The subject is yet in its infancy, but it is a field in which the army surgeon of the future can reap a golden harvest. "A study of the chief tropical diseases would show how many of them . . . . are connected with micro-organisms, which are found in the air, the soil, and the water. The study of these micro-organisms had become a study of prime importance, more especially as not a few had been proved to be closely dependent upon them." Now, to prevent epidemic disease of any kind, we must cast aside all notions of atmospheric waves and the like asylums of political medicine; we can never hope to prevent devastating epidemics on such principles. The limitation of epidemics must rather be founded on the natural history of the diseases as recorded by modern science. In the first place, we act according to the indications given on a preceding page, by avoiding the times and seasons any disease particularly affects, by rejecting individuals especially predisposed to it, &c. In the next place, we act directly on the ferment itself, either by so modifying the ferment as to render it harmless, or by imparting to the blood prophylactic drugs, killing such ferment or preventing the changes it would set up.

Under the first head, we allude to vaccination and inoculation; under the second head, to anti-zymotic medication.

In concluding this chapter, I would earnestly insist on the necessity of a free hand being granted for all the preventive measures against disease arising in a campaigning force. For, in the first place, prevention can overcome the chief effects of the most unhealthy country, and, in the second place, disease arising in an army in the field can frustrate the objects of a campaign. How forcibly was this shown in the expedition to Walcheren in 1809! Walcheren has been described as a pestilential swamp; the diseases met with were chiefly malarial fevers and dysentery, and therefore this example may be fitly brought forward in connection with tropical campaigns. Here, notwithstanding the published account of disease met with in the former campaign of 1745 by Sir John Pringle, we find our officers perishing at the rate of 181 per 1000, and a total loss of life of 8000. Within three months more than half of the garrison of 18,000 died or were invalided, and finally the place evacuated after four months. Subsequent parliamentary inquiry showed, amongst other things, deficiency of stores and a totally inadequate supply of Peruvian bark. "Nothing in the shape of preventive measures seems ever to have been contemplated."

Lastly, I would urge the great benefits that must arise to an army at large, not only in peace, but also to a greater extent in war, by preventive work on the lines of the germ theory. Scoffers at such an opinion there may be. To such I reply, in the words of the illustrious Virchow, who, in speaking of the relation of bacteria to infectious diseases of the army, states that "it is precisely military medicine which is bound to share largely in their value and significance."

CHAPTER II.

SELECTION OF TROOPS.

In the selection of troops for any tropical campaign lies a vital point for the success of that campaign. Various elements enter into this question, of which the chief relate to the following points:—The temperament and diathesis of the individual; the age; previous service and seasoning; previous residence in a good climate; previous medical history; and race selection. I will now indicate briefly the data in respect to the above headings.

The subject of temperament and diathesis in relation to service in the tropics has been exhaustively treated by Dr. Moore, late Surgeon-General of Bombay. No other writer has so clearly laid down the principles of selection of men for tropical service, and to him I am indebted for the remarks that now follow. As regards temperament, Dr. Moore urges that this factor should engage our attention at the outset; he shows that there is in man an original susceptibility to various ailments more or less connected with this factor. The following is the result of his long experience in India. The *sanguine* temperament has been found to be associated with a general tendency to congestive affections, to the rapid and irregular development of disease, to head affections, hepatic abscess, and scurvy. Though the subjects of it are characterized by active muscular systems and high animal courage, they yet live at high pressure, and cannot sustain slight exposure to noxious surrounding influences. The *nervous* temperament is peculiarly sensitive, but there is much energy and capacity of endurance of long fatigue, privation, and exposure. Men of this temperament are, however, prone to disease of the nervous system and hepatic affections. The *bilious* temperament is the one deserving of most attention regarding our present purpose: here the frame is powerful, and the individual possessed of great endurance; he has the least sensibility of all to morbid disturbances and external impressions. As regards the term "bilious," Dr. Moore shows it to be a misnomer, there being in reality no extraordinary tendency to liver affections, except in the extreme form—the melancholic. The bilious temperament possesses the good qualities of the nervous without its irritability, and of the sanguine without its susceptibility to external impressions. Finally, in the *lymphatic* the power of resisting disease is very inferior, whilst at the same time the tendency to liver and digestive derangement is great. Now, during the lapse of ages, the Aryan race has gradually assumed the bilio-nervous type of temperament.

1. Temperament.

Such, then, having been the effect of climate on the Aryan originally coming from the North, it would seem theoretically correct that men of the bilious, or bilio-nervous, type would be the best suited for the tropics. And, practically, such have been found to enjoy the best health, and to withstand longest the enervating climate of the East. But there must be no tendency towards a predominating nervous type; the bilious must be tempered only by the nervous, or not at all. "Nervous" individuals are especially prone to all maladies, and especially to the nervous and hepatic. Next to the bilious, or bilio-nervous, temperament, the sanguine is the most fitted for a tropical life; but, be it remarked, only for a short period, as such a constitution is liable suddenly to give way. The lymphatic temperament is not to be recommended.

2. Diathesis. As regards diathesis, Dr. Moore advises the rejection of all men possessing a rheumatic, scorbutic, or malarious history. The wisdom of this advice will be apparent later on. Meanwhile, it may be stated that men with a family history of rheumatism should be rejected for a tropical campaign, not only on account of the relationship of rheumatism to scurvy, but also on account of the tendency to heart disease, which tendency would be undoubtedly heightened during the fatigues and exposure necessary to a campaign.

3. Age. The third factor to be considered is that of age. Viscount Wolseley, it is well known, urgently demands young soldiers. In his article in the *Nineteenth Century* for March 1881, he states that young non-commissioned officers are as essential as young privates. But the whole history of campaigns, and the experience derived therefrom by medical and combatant opinion, seems to me to lie in the opposite direction. Let us therefore consider some of this evidence.

Egypt, 1798 to 1802. During the war in Egypt in 1798 to 1802, troops were sent from India. Sir John Burgoyne relates that "the 68th Regiment, which came from Bombay, was chiefly composed of boys, and that on the passage fever broke out amongst them, and that they lost nearly half their number, and continued so unhealthy that they were re-embarked and sent back to Bombay; whilst the 61st were nearly all old soldiers, and owing, it is said, to the strict discipline and care of Colonel Carruthers, although they were over 900 strong, and had been 16 weeks on board ship, when they landed at Kossir had only 1 man on the sick list."

First Sikh war. In the first Sikh war, the great Duke, commenting on the attack of the 80th Regiment on the guns at Sobraon, stated that such an attack could only have been performed by old soldiers.

Peninsular war. In the Peninsular war, Sir James M'Grigor's statistics point in the same direction. In nine months the 7th Regiment lost 246 men, the recruits at the rate of 478 per 1000, the old soldiers at that of 67 per 1000—a sevenfold loss on the part of the recruits. In the 40th Regiment, again, the young soldiers suffered a fourfold loss. Sir Wm. Aitken quotes his opinion, which is as follows:—

"Corps which arrived for service in the Peninsula were always ineffective and sickly in proportion as they were made up of men who had recently joined the ranks; he found that 300 men who had served 5 years were more effective and more to be depended on than a regiment of 1000 men who had just arrived and who were young recruits, lads unequal to the harassing duties of service—an experience, he says, which is still more true regarding India."

In the medical history of the Looshai campaign it is expressly stated that the results showed the greater efficiency of the old over the young soldier. He bore fatigue and privation better, and was much less liable to sickness. Looshai.

Surgeon-General Moore, of Bombay, has placed on record how he had to weed out a large number of young soldiers sent to India for immediate service in Afghanistan—"young soldiers who were unable to bear the passage down the Red Sea, which had utterly unfitted them for the toils of an Afghan campaign." Sir Thomas Crawford, the present Director-General of the Army Medical Department, in summing up the effect of short service as regards climate, states that in this war the young soldier contrasted unfavourably with the older, as far as susceptibility to climatic disease was concerned. He became inefficient in the field from lack of power to withstand fatigue and hardship. The adult matured soldier possessed far more power of endurance. For a short period the younger man is as good as the older, but for a long and sustained effort he is not. Finally, Dr. Crawford considers that for service in the field a soldier under 23 years of age is relatively insufficient. Afghanistan, 1878-80.

But as the outcome of his large experience in war, the opinions of Sir Frederick Roberts are still more valuable. In his speech at the Mansion House on February 14, 1881, he conclusively pointed out the weak points in the short-service system, and the results as shown in the Afghan war. He showed how men intended for service abroad did not remain a sufficiently long time with the colours; how absolute boys were often accepted by the recruiting authorities, and sent abroad before they were matured; how non-commissioned officers were discharged from the service just at the period when they were most useful; and how a battalion, when ordered on service to India, was hastily completed by drafts of the youngest soldiers from other regiments, with which it had no local ties or connection. At the outset of the campaign, the Kurram column at first indeed had only one British regiment, composed of a number of "untrained boys." By the time the force had reached Kurram, a distance of only 70 miles, this regiment had dwindled down to a "weak half-battalion." Again, in the great march from Cabul to Candahar, as will be noted immediately, the men who fell out in the British regiments were those of a draft of recently joined young soldiers.

What, then, is the age most suitable for a tropical campaign? The opinion of a large number of authorities is singularly una-

nimous. As regards transmission to India, the Army Sanitary Commission advised that no one under 25 years should land in that country. Dr. Hewlett, the Sanitary Commissioner for Bombay, and Surgeon-Major Welch have also urged the same. Morache is emphatically of opinion that the ages from 25 to 35 are the best for campaigning in the tropics. He adduces in support all the recent experience of the French army in Tunis, Madagascar, Tonquin, and Formosa. The evidence derived from the Mexican campaign agrees with the latter. The experience of the French army in Algeria is to the effect that none but fully formed men should be sent to tropical climates. As at the age of 25 the French soldier passes into the reserve, Morache advocates the formation of a special force of men over 25 for tropical service. Lastly, Sir Frederick Roberts, in advocating the vital importance of old soldiers, defines the term as embracing men of from 5 to 12 years' service.

There can, then, be no doubt that the age of 25 is the age most suitable for campaigning in the tropics. But, as a necessary corollary, it follows that no men should be sent to India under 20 years of age. As the result of Sir Frederick Roberts' speech, it was ruled that no man should be sent to India with less than one year's service, unless he were over 20. It is imperative that this should be adhered to. Sir Wm. Aitken, of the Army Medical School, remarks, in his work on the recruit, that "some years ago it was given to be understood that none would be enlisted for service in India under 20, and finally under 19 years of age, unless for special reasons; yet what do we see in the records of 1873? Over 3500 lads under 20 years of age serving there! and with what dire results to them the influence of age on sickness and mortality abundantly shows." He also shows that the proportion of lads serving in India under 20 years of age is on the increase even, for in 1883 the ratio was 20.5 per 1000, whilst in 1885 it was 36.5 per 1000. The alterations in the terms of enlistment as regards foreign service in the British army since Sir Frederick Roberts drew attention to the subject have materially amended the conditions of its strength. Instead of being enlisted for 6 years' army service and 6 years' reserve, with the option of going into the reserve under certain conditions after 3 years, in the case of men ordered abroad the service in the army is 8 years with 4 years in the reserve, or, in the event of war, 9 years in the army with 3 in the reserve. In concluding the question of age, it will be well to show that the ages of 25 and upwards, on anatomical and medical grounds, are the most suitable for campaigns. As regards the anatomical grounds, let us consider the date of the completion of ossification of the bones of the skeleton. The epiphyses of the spinal vertebræ are not wholly united till the 25th year; there is not complete union of the sacral pieces till the 25th–30th year; the sternal epiphysis of the clavicle is not united to the bone till the 25th year; the acromion to the scapula till the 22nd–25th year; the cartilage of the base of the

scapula and the epiphysis of the glenoid cavity are united at the 25th year; the shaft of the humerus grows till the 25th year; the component parts of the hip-bone unite about the 25th year; the lower part of the thigh-bone about the 20th–25th year; the upper epiphysis of the fibula at the 24th year.

Again, with regard to the viscera, the heart is not matured till the 25th, and the lungs not till the same year.

Thus, the history of the development of the human frame shows that we do not have a perfect individual till 25 years, and even at that age some parts not completely matured.

With regard to disease, the younger the man the greater is the incidence of disease, especially of those maladies likely to be met with in campaigns. In 1879 in India the total death rate for fevers per 1000 at different ages was as follows:—At the age of 24 and under (strength, 22,531), 9.63 per 1000; at 25 to 29 years (strength, 19,028), 5.83 per 1000; at 30 to 34 years (strength, 8987), 4.45 per 1000; at 30 and upwards (strength, 7025), 2.70 per 1000. Again, as regards length of service, in men up to 2 years' service the mortality was 11.77 per 1000; from 3 to 6 years' service, mortality 5.34 per 1000; from 7 to 10 years' service, mortality 3.10 per 1000; 10 years and upwards, mortality 3.03 per 1000. (Report of Army Commission.) As regards enteric fever, the special liability of young men to the disease is greatly increased by service; thus, in 1879 the ratio of mortality in the armies of Bombay and Madras was 1.93 and 1.44 per 1000; whilst in the force of Afghanistan it was 6.84 per 1000. In Tunis, the men of the French army chiefly affected by disease were of the age of 22 or 23; in Tonquin and Formosa, again, dysentery and malaria chiefly seized the men of these ages. So much, then, for the question of age.

4. Previous service in tropics and seasoning.

The valuable statistics of Dr. Bryden especially indicate the adverse effect of sending troops on service on first landing in India. The experience of the British troops of the army in India in 1858 places before us the results that may be expected to follow exposure in the field on first landing in India. Up to 1864 no fresh regiments came to India to take the place of those whose service there had expired. Dr. Bryden gives the following statistics:—

Disease.	Ratio per 1000 of Army of the War Provinces in 1858.	Ratio of Army of 1859.
Dysentery . . .	33.67	12.58
Heat apoplexy . .	17.77	4.40
Fevers	18.57	6.58

This excess in the army of the war provinces was evidently not due to the fact that it was in the field, for, on comparing it with the army of 1858 as a body, we find the following results:—

Disease.	Died out of each 100 Deaths in 1858 and 1859.		
	Army of War Provinces in 1858.	Army of 1858 generally.	Army of 1859.
Dysentery . . .	38.71	38.68	35.61
Heat apoplexy . .	21.92	20.42	12.54
Fevers	21.63	21.34	18.65
Total . .	82.26	80.44	66.80

Here it will be seen that there is very little difference between the army in the field and the army as a whole in 1858.

Again, the daily sick rate of the army of 1858 in the field as a new body under exposure is compared with the average of the army of the 10 years 1860–69; the respective ratios being 117.8 and 6.71. Lastly, statistics show the same excess in the case of new regiments cantoned in the same station in the same year with older regiments; the excess in the aggregate of examples tabulated was as 84 to 52 on the average of the year; or, more fully—

	New Troops.		Old Troops.
Admission rate . . .	2026.8	...	1219.4
Daily sick	84.2	...	52.4
Death rate excluding cholera .	43.7	...	13.7
Death rate from cholera . .	48.5	...	7.2

As regards the selection of troops located in an "intermediate" climate, Laveran holds it unadvisable. He states that in Mexico the troops from Algeria furnished more sick than those coming direct from France. Morache also relates that his experience leads him to conclude that men starting perfectly healthy from France resist tropical disease the better the less the period that has elapsed in an "intermediate" climate.

Let us next consider the question of "seasoning." This factor is also intimately bound up with previous service in the tropics and the age question, but yet a few words concerning the process of "seasoning" *per se* may be here given. By this process all the weak elements of a regiment are eliminated. By "seasoned" soldiers we do not mean men seasoned in tropical disease; as we shall see, previous malarial or bowel disease predispose to further malarial or bowel disease. But by seasoned soldiers we mean men with their weak elements already weeded out by the effect of tropical service. In the fatal Ashanti expedition of 1863, Dr. Gardiner portrays the results of seasoning and of non-seasoning. The 4th W.I. Regiment was sent on service before it had been 12 months in existence. It consisted both of young and unformed recruits and of old men. It broke down. On the contrary, the 2 companies of the 2nd W.I. Regiment that had come up in 1862 from the Gambia bore the climate well, for they were seasoned soldiers.

The great march of General Roberts showed well the effects of seasoning. The force employed was probably the finest that ever

took the field in India. With a small exception, the troops had been thoroughly seasoned by the hardships they had previously undergone, and, as a marching body, were unsurpassed. There was, however, one weak spot. General Roberts caused daily a report of the regiments to be brought before him, in order to judge whether the work was too great. He found that, of the 3 British regiments, the number of men falling out was greatest in the 72nd. Further inquiry showed that a limited portion of the regiment only was affected, and that this portion consisted of a newly arrived batch of men. These had necessarily not had the previous training of their comrades; they were also far younger. In the medical history of this march, Dr. Hanbury pointed out that, whereas the 92nd and 2-60th Regiments daily improved in their marching powers, the 72nd fell off. "The large proportion of young soldiers in this regiment swells its non-effective list." The older men of the 72nd improved like the 92nd, but the young, recently arrived, and unseasoned soldiers fell out. Hence, again, we see that, for endurance, we must have matured soldiers.

5. Previous residence in the Hills.

Previous residence in the Hills is a point in favour of sending a regiment on a campaign. In the Indian contingent for 1882, the 7-1st R.A., from a hill station, was by far the healthiest corps among the European portion of the force. Their admission rate to hospital was only 98.2 per 1000, as compared with the general admission rate of the European force of 210.74. It was even smaller than that of the native regiments, 122.44. The effect of previous residence in unhealthy plain stations has been shown in many campaigns. Even in temperate climates the same bad effect occurs. "At Walcheren a large number of men had already gone through exhausting service in the preceding years, and in the Crimean war those who formed part of the Bulgarian army suffered to a greater extent than the men who went to the Crimea direct."

6. Previous medical history.

Every regiment must be medically inspected as to its fitness before going on service. Especially is the medical history of the regiment to be examined as regards malaria. As will be more particularly pointed out under Malaria, all men with a strong malarious history should be rejected, not only on account of malaria *per se*, but because of the weakened state of the heart induced by it. The functional weakness of the heart will persist after the malarial attacks have passed off, and those affected will be unequal to the strains and hardships of a campaign. The efficiency of an army depends on the efficiency of the men composing it; weak links in the chain are not only harmful of themselves, but hamper the whole machine by detaching elsewhere healthy units to do their work. How great may be the consequences of a want of preliminary inspection was shown in the Aka expedition as regards the transport corps. Composed of coolies from Golaghat, who were cachectic and anæmic from previous work in a malarious country, the corps was not medically inspected before the campaign, and fully one-third broke down. In this respect the preliminary marches of a campaign are often

of service. Thus, in Abyssinia, the first few marches found out the weak men, and so the authorities were enabled to eliminate them in time before proceeding to the highlands.

7. Race selection. Again, much sickness is due to bad selection as regards race selection. Up-country native regiments in India have been brought down to serve on the north-east frontier of India, where the climate, food, and general environment are totally different to their former experience. The up-country Sepoy does not enjoy good health in Bengal. Sir Ranald Martin shows how, after two or three years' residence in the lower provinces, the robust up-country Sepoy wastes, and falls a victim to the fevers, dysenteries, and diarrhœas of an unnatural climate. This was well exemplified in the first Burmese war, where the Sepoy of the higher region was transferred to the malarious regions and marshes of Arracan. Hence, for the north-west frontier of India, Punjab regiments are indicated; for the north-east, Assam regiments. Such are at once at home in the respective countries; the conditions of warfare as well as of climate come more naturally to them; thus, for instance, clearing away jungle, hutting, &c., would be no new condition for the men thus chosen for the north-east frontier.

For service outside India, as regards native troops, the Punjab races are indicated. From caste prejudices, the Hindustanis are unsuited; the nature of their food also renders them less capable of suffering the hardships of war.

Finally, although the selection of the material is of vital importance, yet, if other data be neglected, an expedition will come to grief. Every detail in hygiene must be attended to; otherwise, after a time the most splendid force will be shattered equally with an inferior body. Thus, the picked men of the Caucasus availed in no degree to avert the disasters of the Turcoman campaign.

Acclimatization.—A few words may be stated on acclimatization. The subject is confessedly difficult. As we shall see in the special part, individuals are "acclimatized" in some cases to certain diseases—*e.g.*, yellow fever, by having lived in the (yellow fever) region, or by having had the disease; whereas, in other diseases—*e.g.*, in malarial fevers and bowel affections—previous attacks render the subject more liable to future attacks. To us the process of "seasoning" would be different to that of "acclimatization;" in "seasoning" we have essentially the survival of the fittest. Seasoned troops are not those which have simply gone through fatigue, and therefore are best qualified to bear more, but are those who have in the process lost their weak members by selection; but in acclimatization we have an adaptation to the environment, it is true, but in such adaptation the subject has become more or less deteriorated. The "seasoned" soldier on reaching England is as fit for service in England as he was before he left for India, probably fitter; but the acclimatized soldier is not so: he has to reverse the recent process of adaptation to the environment, and to become more robust before he can be equal to his former state. Thus, in my view of the matter, a "seasoned" soldier is better than an "acclimatized" soldier. It

is somewhat difficult to express this idea in words, however. Perhaps it may be best enunciated by stating that in a prolonged residence in India two factors come into play—(1) Adaptation to the environment; (2) Natural selection. Now, the factor of natural selection especially is the factor of "seasoning"—the "seasoning" process has eliminated all the weak elements; whilst the factor of adaptation is the especial factor of "acclimatization." And in this way we see that a "naturally selected" soldier is better material than an "adapted" soldier.

Example of selection. China war, 1860.

I now conclude this chapter with an example of the effects of selection. In the China war of 1860, before the troops left Hongkong for Pechli Bay, every delicate man was weeded out; the force started with a good bill of health. Now, the total sickness and mortality due to the campaign were at the rates of 2049 admissions and 53.98 deaths per 1000. This though high for the hygiene of to-day, yet was better than the rates *of the previous peace year*, 1859—viz., admissions, 2783.2, and deaths, 59.35 per 1000.

CHAPTER III.

SELECTION OF SEASON.

The selection of the proper season for the campaign is one of great moment. This point has ever been dwelt on by all writers on military hygiene. Thus, the first injunction of Morache concerning an expedition to the tropics is to choose that period of the year which is the most healthy in the region of attack, and to commence operations so as to ensure the army at least two or three months of this healthy period. The influence of selection has been shown in many of our campaigns. In the analytical exposition I have gone into the question of season in respect to the several tropical diseases, from which it would appear that the general rule is to avoid the hot and rainy seasons. In this place I propose to give a few general illustrations of the relation of season to health in any expedition in warm countries. Now, by a judicious selection we may not only avoid the most unhealthy portions of the year, but we may also so time the advance as to come in for the best period for supplies. The period in which the advance was made on Pekin in the China war of 1860 is a good illustration. The advance began on September 10, just when the cold weather was setting in, and also just when the products of harvest were coming in. At every camp our men obtained abundantly vegetables, fruit, sweet potatoes, hay, stacks of straw; "it was literally a land of plenty." In the first chapter I have already shown the difference in the results of operating in Ashanti in the rainy and in the cold seasons. In the Malay expedition, again, the medical historian points out the good effect of having operated in the healthiest time of year in the peninsula. Had the operations been conducted later, the force would have been exposed to dense fogs by day and heavy dews by night, rendering all bivouacs dangerous. After the setting in of the south-west monsoon in March, it is most dangerous for troops to bivouac in these parts. And when it is determined to proceed as light as possible, selection of the cool season is imperative. In the frontier campaigns of India the force bivouacs: a brother officer who was throughout the Jowaki campaign informed the author that his regiment was never fitter. But in the hot and rainy seasons it would be impossible to bivouac. It is true that in Jowaki much rain was experienced; but rain in the cold season is comparatively harmless to rain in the hot season. The history of our relations with Looshai on the north-west frontier of India shows how a campaign in the rainy season

may be rendered abortive. Thus, the Cachar column under General Nuthall in 1869, which proceeded up the Dullesur, was obliged by rain to turn back before reaching the enemy's country, whilst the Munipur contingent was likewise prevented by stress of weather from doing anything.

Take, again, the Soudan and Egypt. The *Times*, in a telegram dated Alexandria, March 31, 1885, stated that out of a British force total of 24,754 in the Delta, Soudan, Suakim, there were only 965 on the sick list, or under 4 per cent. Again, a correspondent to the *British Medical Journal*, writing from Assouan, November 3, 1884, stated that at that date "the climate was delightful." The temperature was always under 80° in the shade by day, with a strong fine north wind. The food supplies of vegetables were abundant, potatoes, onions, melons, and gourds being easily obtainable.

Again, a correspondent to the *Lancet* with regard to the Soudan and Suakim states that during the months from October to the beginning of April the climate is pleasant and healthy enough, with genial warm days, cool nights, a cloudless sky, dryness of air, an average daily temperature of 78° F., refreshing sea breezes setting in about 10 A.M., and continuing till after dark. "The existence of so small a percentage of sick amongst the number employed during the past three months is more than confirmatory that at this season the climate of the Soudan is by no means prejudicial to health; but let April pass, and a complete change sets in." The thermometer then measures 112° F. in shade, and remains at 100° F. during the night. No fresh sea breeze now sets in to cool this heat; the superheated air becomes terribly relaxing; the depression increases hourly; and heat apoplexy strikes its victim. Again, in the medical history of the native Egyptian army in 1884 we find it recorded that there is no oppressive heat in Suakim till June. In July and August it is intense. In tents with double fly the thermometer rose to 125° F. In "cool" places on board ship it was 110° F. The nights were also very oppressive from the absence of wind. A brother medical officer was ordered to Suakim in June, and after some time he wrote, and said that during his service of over twenty years in India he had never seen anything like the climate. At the same time letters were appearing in the Indian Press to the effect that the Indian regiments were only very partly housed, and moreover were compelled to do all the monotonous and laborious work appertaining to a camp. In the words of the correspondent of the *Lancet* in the above description of the Soudan—"Nothing short of sheer madness should tempt any Government to sanction the retention of troops under canvas in so dangerous a summer climate as that of the Soudan."

As regards operating at the unhealthy season of the year, the first Burmese war gives us a warning. The expedition arrived at Rangoon in May. The rainy monsoon was just setting in. In June the force "already had been much diminished by sickness and death brought on by hard service during an inclement season."

In July the rains were at their height, and sickness had attained such an alarming extent that the "prospect of a successful termination to the contest became daily more gloomy."

A final illustration of the influence of season may be given in the Russian campaign against the Turcomans in 1879. We have already partly alluded to this. Major-General Markozoff has drawn up a memorandum imputing the failure of the expedition to its having been undertaken at the wrong season of the year. All authorities, moreover, concur in stating that the force started too late to escape the torrid heat of the desert sun. O'Donovan, in his visit to Tchat in April, says the heat was already intense, and the desert parched and bare of vegetation. In October, when he traversed the same road again, "grass was everywhere clothing the plain with a mantle."

Of course Government cannot always choose its season for operations, but with due care provision can be made. The operations of war in 1882 were conducted in the hot season, but the effects of the hot season were more than counterbalanced—not, indeed, by the arrangements that sent out the hospital stores at the bottom of a transport, such transport not even being the ship appropriated for a hospital ship—but by the hygiene instituted by the medical staff. And the result was that the campaign was the healthiest hitherto waged in our history. The moral, then, is —If possible, to choose the cool season of the year for campaigns in warm countries, but, if not possible, to make common-sense provisions, which provisions should be as impartially bestowed on native as on European troops. Even in temperate climates our wars in the past have shown a disregard for these elementary principles. Thus the climate and diseases of Walcheren had been accurately described by Pringle in 1764, yet nothing was known to Government in 1809. During the very months of summer and autumn, in which the climate had been shown to be worst, the British force landed. The consequences were lethal: "The expedition to Walcheren was the fruit of statistical ignorance in every one, and cost us 10,000 brave men" (Marshall).

CHAPTER IV.

TRANSPORT SHIPS AND THE QUESTION OF DEBARKATION.

In campaigns we have to convey our men from England by sea to the scene of action, as, for instance, in Ashanti and Egypt. The environment on board the transports demands, therefore, a brief consideration.

Overcrowding.—The great indication to start with *is to avoid all overcrowding.* Pringle shows how even in temperate climates overcrowding inevitably bears evil results, such as typhus fever outbreaks. Sir Ranald Martin has especially drawn attention to the fact that, if the men have been overcrowded on the voyage, they will, on landing, be peculiarly liable to endemic and epidemic disease. Especially is the element of overcrowding to be provided for in ships chartered for transport. Such vessels not being built to act as troopers, overcrowding is more likely to occur from the irregular disposition of the troops. That a long voyage can be brought to a conclusion with the men in perfect health was shown in the war in Egypt in 1801–2. The army that landed on the west coast of the Red Sea was in a splendid state of health, "due to the wise sanitary measures adopted during the long confinement of six months on board ship." Here the transports were large, lofty, and roomy. One ship, however, the *Minerva*, sailed from Bombay "much crowded," and in a three weeks' passage to Ceylon had great sickness; three ships having been substituted for one, however, the *Minerva* remained healthy during the rest of the voyage. In the China war of 1860 the troops sailing frcm Calcutta reached Hongkong, after a fifty-seven days' voyage, in good health, due especially to the liberal space allowed cn board ship. Again, therefore, we see how the element of overcrowding invariably induces disease; in the case just mentioned in the three weeks' passage to Ceylon, three deaths occurred; after the crowding was reduced to one-third, not a single death occurred during the remaining month's voyage to Egypt. Regarding the space to be allowed for each man, Sir Ranald Martin lays down that for two tons of measurement only one man is to be carried. Hirsch, again, relates how outbreaks of "ship malaria" arise in over-crowded, ill-ventilated transports. In a French ship of war carrying troops and convicts from Toulon to the West Indies and Guiana, the ports had to be closed on account of bad weather, no ventilation on the lower gun-deck was possible, whilst the impure air in it was aggravated by a frightful stench from the

bilges, the gun-deck being all the while crowded with men. Over 60 persons were seized with malarial fever, nearly all of whom were located in the lower gun-deck. As a final instance of the evil effects of overcrowding, Dr. Rennie, in his work, *The British Army in North China and Japan*, draws attention to the fact that the *Mauritius* was the only vessel out of 200 ships at anchor off the Peiho on board which anything like epidemic fever broke out. Rennie holds this fact to be due to the want of adequate accommodation.

During the voyage, also, every care should be taken to ward off *ennui* from the men; athletic exercises should be daily instituted. Especially during night should provision be made for ventilation; let the ports, weather permitting, be always open. The British soldier is fond of closeness.

Debarkation.—The next question is that of debarkation. Now, the main precaution is *not* to land the men until all arrangements are made for their supplies and onward movement. In the first Burmese war, after the capture of Rangoon in May 1824 our troops found that all the people of the country from whom supplies could be obtained had fled, whilst there was a total want of provision for movement forward by land or water. The army had come unprovided with the necessary equipment for advance, as it was thought the mere capture of Rangoon would bring peace, or that both supplies and transport would be placed at our disposal. But our intelligence was all wrong; every boat had been removed, and thus the army found itself at the beginning of the rainy season without any means of transport. What was the result? Fever and dysentery rapidly reduced the force. Even by the end of November the force was unprovided with the means of moving a single company, and was still waiting for equipment from Calcutta and Madras. In the China war the troops were detained in harbour for a few days to see if any defects existed in the supplies. The Russian expedition against the Turcomans, already alluded to, again gives us an impressive warning. The troops were landed at Tchikishlar before they could be marched up the Atrek. The landing-place was notoriously unhealthy, without resources, and on the edge of a burning desert. Now, the force, instead of remaining at Baku, the opposite side of the Caspian, until all supplies and transport were ready to convey them away from this unhealthy spot, landed before the supplies; hence, as fast as the latter were landed they were consumed by the troops; the transport also being deficient, a reserve sufficient for the advance could not be accumulated. Had the opposite tactics been pursued, the men could, when all was ready for them, have been conveyed across the Caspian, landed, and then marched straight away up country in good health.

As regards the place chosen for debarkation, let it be in as healthy a situation as possible, and, leaving sufficient men for defensive and necessary purposes, march the rest away, especially if there be higher land in the neighbourhood. Never crowd the landing-place; get the men off on the line of advance as soon as

possible. In the late Burmese war attention was not always paid to this. Thus, two squadrons of cavalry, on arrival at Rangoon, found no steamers to receive them. They had to bivouac out all night on the strand bank, and, as heavy rain fell, they were not in the best condition next morning. This was a good preparation for men about to enter on service in a malarious climate ! Again, a European regiment was kept waiting on the strand bank at Rangoon for a whole day in the sun with scarcely any shelter.

Coolie transport.

The same laws regarding transport for followers are necessary. Indeed, here especially must sanitation be looked after. The bearing of the defective arrangements on cholera will be especially pointed out in the appointed place. Meanwhile, too little space is apt to be allotted for followers. On the s.s. *Darien*, proceeding to the Soudan, Hendley points out that the space allotted to 950 followers would have been overcrowded with only 600. Although the deck was utilized, yet the men overlapped one another when sleeping. Luckily the voyage was only for eleven days.

CHAPTER V.

DRESS AND BEDDING.

THE subject of clothing is of the greatest importance, and merits a full disquisition. With the dress we shall also consider shortly the bedding. "The bed," says Pettenkofer, "is a sleeping garment, and may prove a source of great benefit or harm just as our clothes can."

Let us first see how our men, and men of some other nations, have been clothed in war.

New Zealand, 1863-5. In the New Zealand campaign, during the semi-tropical heats of summer, each man had a loose blue serge suit, 2 flannel shirts, a white cap, a great-coat, waterproof sheet, and 2 blankets. For boots they had the ordinary ammunition boot, and the "Daubeny" boot; the latter was reported on by the principal medical officer after the war as the best service boot yet made. It has a broad sole, a good heel, and comfortable lacing. No cholera belts apparently were given, as their issue was recommended for any future campaign.

Abyssinia, 1867. In the Abyssinian war the men had 1 serge and 1 khaki suit, 2 flannel shirts, 1 blanket, and waterproof for bedding. But when we say "the men," the native troops must not always be included; in one instance, only *one* khaki suit was doled out to them. The result was, that this suit was rarely dry. "Bowel complaints" consequently headed the mortality and invaliding.

Ashanti, 1873. In the Ashanti war the equipment for the British troops consisted of 2 Elcho frocks, 1 pair tweed trousers, 1 pair duck trousers, 2 flannel shirts, 1 waterproof sheet, 1 pair canvas gaiters, 1 greatcoat, 2 pairs of boots, socks, helmet, and puggaree.

Sunjhie-ujong, 1874. In the Sunjhie-ujong expedition, the dress—reported on as an excellent dress for the jungle—consisted of a wicker helmet, 2 flannel shirts, cholera belts, two to each man, and white trousers. Gaiters were at first issued, but soon discarded by the men, who found it more comfortable to tuck their trousers inside the socks.

Malay, 1875. In the Malay expedition, each man had 1 serge suit and 2 khaki suits, 1 cholera belt, woollen socks and shirts, leather gaiters, and Kilmarnock night-caps. The khaki suits were unfavourably reported on for damp climates like that of Perak, for, unless frequently washed and artificially dried, they became damp and clammy, and always felt cold in the morning. The leather gaiters also were found to be too hot, and, when wet, to become soft and pulpy.

Jowaki, 1877. In Jowaki the men had a khaki and serge tunic; for bedding,

2 blankets and 1 cotton rug; also their great-coats. In this expedition no tents were taken. The principal medical officer suggested for similar future expeditions, that in lieu of the second blanket and cotton rug, which during rain become saturated, a waterproof sheet, 6 feet by 3 feet, should be substituted. It would only weigh 1 lb. 14 oz., against the 8 lb. 2 oz. of blanket and rug.

In the Afghan war, during the hot weather, the men wore flannel shirts and khaki in the British regiments; the native regiments wore khaki. A cholera belt was also issued to each man. Afghan war, 1878-80.

In Egypt in 1882 the mounted branch wore blue serge frocks, waistcoats, trousers, ordinary breeches, field service riding-boots, canvas trousers, gaiters, puttees, flannel belts, great-coat, and ordinary helmet. Egypt, 1882.

The infantry were equipped with undress grey frocks, waistcoats, flannel belts, trousers, gaiters, puttees, ammunition boots, great-coats, and grey blanket.

In the Indian contingent, the cavalry had khaki tunic and breeches, puttees, ankle boots; the infantry had khaki tunic and trousers, gaiters, and ammunition boots.

Khaki clothing was issued for the Aka expedition. Socks were only issued in the 43rd Assam L.I., and were found of great service. Each man carried a blanket and a waterproof sheet, but the amount of bedding was considered too small. Aka, 1883.

In the Eastern Soudan, grey flannel clothing was worn by the British troops, and khaki by the troops from India. In reporting on this expedition the principal medical officer recorded that even for very hot climates khaki was not so suitable as serge or wool, especially when the force has to bivouac. The puttees especially were found serviceable. Eastern Soudan, 1884.

In the ordering of a war uniform, the first injunction is to be found in the statement that the truest economy consists in the issue of the very best kind of clothing recommended. It will be well to review briefly the specific properties of the various fabrics that have been proposed for the soldier; then to consider the ends to be kept in view in clothing the soldier; and, finally, to point out the indications deduced from these points for each separate portion of the soldier's dress. Issue very best clothing.

The properties of clothing that especially concern us in hot climates are those connected with absorption and conduction of heat; permeability of air; absorption of contagions and odours; and durability. In these points we find material and colour exert very wide differences. With regard to absorption, this factor has to be considered with respect to heat, infectious principles, and moisture.

Cotton is durable, non-absorbent of moisture, not very permeable to air, very absorbent of odours, and therefore probably of infective ferments. Having these properties, it certainly is not the material for the campaigning dress in hot climates. Taking cotton, linen, and khaki together, for their respective properties in

all respects are such that they may be considered as one, we find (1) that the non-absorbing power of these materials as regards moisture is eminently unfavourable to the soldier on the war-path. The soldier is practically always working; consequently, always more or less perspiring; the perspiration passes through the non-absorbing material, and, evaporating, produces chill. (2) Again, permeability to air is an important factor as regards health in a dress, but taking the permeability of flannel as 100, that of linen is only 58. (3) Our men are not always able to wash their clothes regularly. Now, Pettenkofer has shown that linen and cotton clothes which have been worn smell much stronger than woollen clothes. In fact, a woollen shirt which has been worn for a month does not smell nearly so badly as a linen one which has been worn for only a week. Now, inasmuch "as the absorption of odours is supposed to resemble that of contagions," we see that cotton in these respects is at a decided disadvantage to wool on a campaign.

As regards absorption of heat, the powers of cotton and flannel may be considered equal. White cotton being taken as 100, white flannel will be represented as 102 in this respect. But as regards conduction of heat, cotton has much larger powers than wool.

Wool.

Now contrast wool with cotton in these respects. It has great absorbing powers of moisture. During exertion the evaporation of the perspiration from the body acts as one of the great cooling powers of the body; now, the vapour from the skin becomes condensed in the wool after exertion, and so returns to the body the large amount of heat rendered latent when the perspiration was becoming vaporized; thus, chills are kept off, and a pleasant feeling of warmth occurs to the body. Again, as a conductor of heat it is very slow; here again, after exertion, heat will not be rapidly conducted from the body as in the case of cotton, and here, therefore, again, chills will be avoided. The permeability to air—so necessary for the healthy exchange of gases and a healthy atmosphere immediately round the body—is nearly double that of cotton.

Purposes of clothing.

Next, let us consider what are the indications to be carried out as regards the soldier's dress in hot-climate campaigns. They are the following:—

1. To reduce the absorption and conduction of heat, and thus to avoid the condition producing sunstroke.
2. To maintain an equable temperature, and thus to avoid all those diseases of campaigns brought on by chill.
3. To obviate as far as possible the bad effects resulting from want of opportunity of washing.
4. To obviate all action adjuvant to infection.
5. To ensure as much reduction of fatigue from mechanical work as possible, and so to lessen liability to heat-stroke.

Such being the purposes to be fulfilled, we find that cotton and wool may be considered equal as regards their absorbing power of heat; but in its far less power of conducting heat, in its far greater power of absorbing moisture and of maintaining an

equable temperature round the body, in its better hygienic condition where clothes cannot be washed, and in its less power of absorbing contagious principles, flannel is immeasurably superior to cotton stuffs. And this has been the general experience of campaigns: flannel has been found to be the best preservative against sickness. There is a general consensus of opinion that flannel and woollen stuffs should be used, and none other. One officer of experience has, however, come to the conclusion that all the above supposed advantages of flannel are erroneous. Dr. Veale says in his paper that it has never been found to protect men from tropical disease; but, on the contrary, that it in all probability predisposes them to diseases of the circulation; that it renders the skin over-sensitive to sudden changes; that soldiers "encased in it" are unable to endure long marches, and fall victims to sunstroke, ardent fever, and cardiac failure. All I can say in answer to Dr. Veale is—that this experience is contrary to general experience, for flannel *has* been found, by other authorities of equal experience, to protect from tropical disease; secondly, that it does not render the skin more liable to sudden changes, for of itself it diminishes these changes; and, thirdly, that there is no reason why our men should be "*encased*" in it and, moreover, I have never seen our men "encased" in any dress in the field. I advise strongly against any other material than flannel or wool ever being employed for the soldier's campaigning dress in hot climates. It may be taken, then, for granted that cotton and linen are *not* the materials for a campaigning dress.

Dr. Veale's views.

The highest perfection, however, in the material for a campaigning dress in hot climates would seem to be that introduced by Dr. Jaeger. This inventor has supplied the army with various kinds of his wool sanitary clothing, one kind being adapted for the tropics. It has already been introduced into the German army. No linen is worn; wool is everywhere in contact with the skin. The clothing has been so manufactured as to be perfectly unirritating to the skin; the material preserves an equable temperature round the body; the shape and arrangement of the constituent hairs of the texture provide for the escape of moisture by capillary attraction; and they equally act as the best conductors of the various fluid impurities, decomposing fatty acids, &c., from the skin. It seems to me that this sanitary wool clothing is exactly the clothing wanted for campaigning in hot climates, in which, as we have seen, alterations between the day and night temperatures so frequently come into play.

Jaeger's sanitary clothing.

To sum up, then. The campaigning soldier should wear next the skin textures of the nature of flannel. Jaeger's material is the best as yet invented. But whatever be the form of wool which is selected, the material should be the best of its kind. This will secure absence of all coarse, irritating material. We can well imagine a rough, coarse flannel shirt cannot be pleasant to wear; the coarseness especially in part being due to a large admixture of cotton. Again, there can be no doubt that such material is

the coolest material to wear. Every one knows that it is far more agreeable to wear a merino vest under exertion than to be without one; in the same way, it is far cooler to march in the heat with flannel next the skin. In the hottest days in India the coolest materials to wear are flannels. Sir Ranald Martin's experiment shows this fact forcibly. Place two beds in the same room during the day when the temperature is 90° F.; let one be covered with a pair of blankets, and the other with a pair of linen sheets. Remove both coverings in the evening: the bed on which the blankets were placed will be cool; the other warm. Substitute a man for the bed, and we see how important a factor material will be as regards prevention of sunstroke.

Colour.

A word as to the *colour* of the material chosen. Colour influences absorption of heat greatly. In fact, as regards absorption of heat, much more influence is exerted by colour than by material. The experiments at Aldershot about six years ago showed the small absorptive power of white as compared to other colours. Again, the *Madras Manual of Hygiene* states, in this respect, white cotton being taken as 100, pale straw will be 102, dark yellow 140, light green 155, dark green 168, Turkey red 165, light blue 198, black 208. Dr. Cordier has also shown that by placing a white cotton cloth over a cloth dress the temperature is lowered 7° per cent. Again, the absorption of "contagions" is also influenced by colour; black absorbing most, then blue, red, green, yellow, and finally white least.

Thus, we see white is the best colour; this, however, is manifestly unfit for a campaign; the colour should be therefore grey, or a pale straw colour; in fact, some of the hues of khaki answer exactly to the requisite colour for campaigning. From the Aldershot experiments grey could be used; its absorbing power was next to white, and less than yellow.

Having now selected our material and its colour, let us apply these to the various articles of dress. And to gain an idea of what a military dress ought to be, let us learn first what a military dress in tropical campaigns ought not to be. The men of the late French expedition to Tonquin were dressed in a manner that surely was not to be expected in the countrymen of Morache. Here, even in May, a considerable proportion of the French soldiers wore the kepi, the blue cloth coat (heat-absorbing power 198, compared to white 100), heavy scarlet flannel (heat-absorbing power 165, compared to white 100), breeches, coarse linen shirt, and thick flannel singlet; whilst for head protection they had only the ordinary peaked cap. No wonder that, in clothing such as the above, "the men died suffocated by the heat, worn out by the weight of unfit clothing, and smitten by the sun through the little peaked cap."

French in Tonquin.

Head.

The head covering will be found fully entered into in the chapter on Sunstroke. Here I would merely state that I hold the present helmet unfitted for its purpose. This has at length been found out at Suakim. As the Suakim correspondent to the *British Medical Journal* stated, the present helmets were not suitable for

the Khartoum expedition. "The temples are left exposed. There is a hat, at present worn by the Royal Engineers at Suakim, which, though not so smart-looking as the white helmet, is the one the authorities ought to supply to all hands. It is a thick pith hat with a wide brim, and covers over the nape of the neck and sides of the face like a sou'wester." This pith hat is, of course, no other than a good thick large solah topi, such as is worn by all sportsmen in the jungles. Sport is but "the image of war" as far as jungle life is concerned, and we may be sure the Indian sportsman knows the best dress.

The material and colour we have already seen. Linen and cotton are never to be worn next the skin, but always wool in one of its forms. Now, I have said that one of the purposes to be held in view in clothing the soldier is to ensure as little fatigue from mechanical work as possible. Therefore, above all, he is not to be "encased" in his work. This fact has slowly been forced into the unreceptic soil of the Army Clothing Department. Mr. Stanley's advice, in his recent work on the Congo, might well be borne in mind by the clothing committees of the army. "The body must be divested of that armour in which it was accustomed to be encased in high latitudes, and must assume garments of soft, loose, light flannels. The decorous externals of Europe must yield to the more graceful and airy flannel of the tropics." Thus, the dress of the soldier in the tropics must be soft, light, loose, and airy. By thus giving complete freedom of movement we diminish mechanical work, and with it heat production from mechanical work, and so we diminish one factor in heat-stroke. Thurn has shown how new tight clothing predisposes to heat-stroke, and fluxion to the heart and brain during marching in hot climates, not only from the element of fatigue, but also from the necessary formation of a layer of moist air between the clothing and skin, still further hindering the evaporation of heat from the body. Body.

So much, then, being premised, we would give the soldier merino jerseys of soft and light material (as many as possible being granted) and two flannel shirts. To prevent shrinking of the collar, let the latter be of linen. (When I use the word "flannel" or "woollen," I would be always understood to urge that best form of all, Jaeger's sanitary clothing.) Next, he should have a protector for the abdomen—the cummerbund. And not only should he have at least two of these, but also there should be instituted parades for the purpose of seeing if they are being worn. These parades should be held at uncertain hours. The importance of attending to the under-clothing is evident from instances such as the following:—In the Kurram Valley, the men of a battery to which I was attached complained of fever and bowel complaints, and were coming into hospital. I recommended that each gunner be supplied with a woollen jersey. Fortunately, these were easily obtainable, and the admission rate for the above at once diminished. In the Looshai expedition the 42nd A.L.I. were unprovided with flannel belts for the abdomen, and conse-

quently there was in this regiment an excess of prevalence and severity of bowel disorder.

In lieu of the cummerbund worn by day, a light flannel waistcoat, reaching well down over the stomach, could be substituted. This waistcoat is worn in Algeria by the French army with much benefit. At night a cummerbund could be worn.

As regards the coat, either the Norfolk jacket, or a very loose blouse, has with doubt the best shape. Both give every freedom of movement. For British soldiers I would recommend a loose Norfolk jacket; for native, a blouse. As regards the material, inasmuch as the under-clothing has now been well arranged for, one coat need not be of woollen material, but the second coat should always be so constituted. A dry woollen coat at hand after every march would be of the greatest aid as a preservative against chills. It is needless to say the collar must allow of the most perfect freedom of the neck.

Lower extremities.

As regards the leg dress, a knickerbocker, with prolongation down the leg to the ankle, cut to the shape of the lower leg, is not only one of the neatest, but a most comfortable dress. The 14th Sikhs are dressed in such a pattern, and on the line of march the regiment shows one of the most serviceable patterns of dress I am acquainted with. Leggings have been recommended: if of leather, they soon get out of shape and rotten from the climate; of canvas, they are more serviceable. For the future, however, "putties"—a woollen bandage round the leg—will be used by all who have tried them. They certainly form a most comfortable support for the leg, and are equally serviceable for the cavalry as for the infantry; and not only have they these properties, but they serve to protect the legs from the bites of insects. As we shall see in the proper chapter, they were of the greatest use in the Aka expedition against the bites of the pepsee fly, and the men were ordered never to be without them. Finally, each coat should have let in down the middle of the back, a broad spinal pad. This pad—to be of wool—is only rarely observed in campaigns, but I hold the protection of the spine in hot countries is of equal importance to the protection of the head. In the Affghan war I observed only a few in use amongst the officers, and none amongst the men. Their want was also felt at the beginning of the Khartoum expedition, especially by the "camelry," for in no position were the sun's rays more severely felt on the back than when exposed to them on the back of a camel.

Feet.

The foot gear is one of the most important of the whole on the day of action and on the line of march. This fact has been fully appreciated by the Russians, for it is said that no army in the world is so well supplied with boots as the Russian. A special soft leather is prepared. Pliability is aimed at, and footsoreness is said to be unknown. The English ammunition boot, when once the initial hardness has disappeared—and how hard that hardness is, only those can tell who have experienced it—is a good boot, but it has inherent defects in its great hardness and in the sharp edges of the pieced leather. It is truly hard on the soldier that

attention to details cannot be paid in such an important matter as the boot. It is manifest that a hard projecting seam pressing on the hot perspiring foot of the soldier on the line of march in a tropical country must soon blister him. I would like some of the manufacturers who have supplied such boots to have been compelled to march twelve miles in them fully accoutred. Still, the idea of the boot is good, and their wear is most excellent, provided always they be of English manufacture. During the Afghan war a number of boots were issued to the men from an Indian manufactory; being of native leather, they soon got out of shape, the sides turned over, and they became most uncomfortable to walk in. In General Roberts' march to Candahar, the ammunition boot, being, at that period of the war, of bad material, got out of shape; blisters of the feet caused *half* the inefficiency in the march. But as regards the wear of the English boot, it cannot be beaten. The improvements to be sought for are, greater care in finishing, far greater suppleness of leather, and a fastening by means of a leather strap and buckle in lieu of laces. The heel also should be broader and flat. As everything that lessens fatigue, or can produce speed with less expenditure of force, is to be sought for in the tropics, even so small an item as the heels of one's boots deserves attention. For M. Marey has shown, by experiments with the odograph on the marching powers of soldiers, that low heels exert a very favouring influence on the pace at which a man walks, the rhythm of the steps having an important influence on the speed, and low flat heels having an important influence on the rhythm. As regards socks, the present sock is an excellent one.

Native Army.—The question of shoeing is a most important one for the native army; there is here much room for improvement. Connected with shoeing is also the question of socks. Now, practically, the sock is not worn by the native army. Dr. Lewtas showed the following results from this want of proper equipment:—In 1872 there were 53,996 native troops serving in the Bengal Presidency, and 54,583 Europeam troops, or, practically, an equal strength. But the admission rate for "blisters of the feet" in the European troops *was as* 1.3 *to* 34.6 in the native troops! Thus, our native army suffered, from a wholly preventable cause, to a degree 34 times in excess of their British comrades. And that the footsoreness and blisters were caused by the want of socks is evident from many instances. For example, in the Malay war, the 1st Ghoorkhas were supplied with socks, and we read in the medical history of that campaign that, whilst they lasted, there was but little footsoreness. Not only is it necessary, therefore, to supply socks, but also *durable* socks, to the native army. In the Duffla campaign some of the socks issued did not last a fortnight. As regards the best boot or shoe for a native soldier, much difference of opinion exists. One of the most efficient native infantry regiments with which I have served is the 23rd Pioneers. No regiment, probably, excels it in fighting and marching powers. This regiment wore the ammunition boot in the Afghan war, and

Shoes.

certainly marched and got over as much ground as any other corps in that war. The opinion held concerning the ammunition boot was that it constituted the best form of boot for the native army; but other officers hold that the ordinary native shoe is as good. As regards actual entries into hospital for "blistered feet," the infantry of the Guides had fewer admissions during the Afghan war than any other regiment. Here the form of shoe known as the "chapli" and a leathern sock were worn.

In the selection of a shoe, one of the chief points to be borne in mind is the durability of the article. In this respect the ammunition boot is by far the best. Native troops soon get accustomed to it, and even prefer it to their own ordinary shoe. But to render it a perfect boot for the native army, four points must be attended to. The native soldier on a campaign must be as liberally supplied with socks as the British. The hard unyielding leather and seams prominently raised on the inside of the boot are provocative of blisters. If socks cannot be granted, then a flannel bandage similar to that used in the German army should be issued. Secondly, the boot should be always used. Its use should not alternate with that of the ordinary shoe, otherwise the men get unaccustomed to the boot, and, on resuming it, a large entry for blistered feet will result. This was strikingly shown even in the 23rd Pioneers in marching down from the Pishin Valley in 1885. The men had been for some months previously working in native shoes; on the first march out, the ammunition boot was resumed. During the first three days' march, there were nearly 40 men rendered unfit for marching on account of blisters. Thirdly, the shape of the native foot being different to that of the European, the shapes of the boot authorized should be regulated accordingly. The native has a projecting heel, and often a boot long enough is found to be too wide, and too big round the ankle. Hence, sizes for native troops should be manufactured. Lastly, as before remarked, the leather should be of the best. Certain objections have been urged, however, to the use of the ammunition boot for native soldiers. It is said that the best shoe for the native army must be that to which they have been accustomed from their youth up. This has at first sight a certain amount of truth; but in my experience the men, when accustomed to the ammunition boot, prefer it to any other. Secondly, there is the question of greater expense. Yet the truest economy will be found in equipping the soldier with the best of everything. Thirdly, the shape of the British ammunition boot is not adapted to the native foot. This, however, can be remedied by having special shapes for the native army.

Were it not for the greater durability of the ammunition boot, I hold that the chapli and leather sock as worn by the Guides infantry constitute the best form of shoe. There were fewer admissions for blistered feet in the corps during the Afghan war than in any other. Nothing can be more comfortable to wear, but in a lengthy campaign it might be difficult to replace them.

The ordinary native shoe, however, has its adherents. There

are, nevertheless, many objections to it. It is not durable; it constantly acts as a receptacle for sand, stones, &c. In the medical report on General Roberts' march from Cabul to Candahar it is opined "that the native shoe, with its wide open mouth and narrow pointed toe, seems contrived to cripple and blister." Again, on muddy ground it is with difficulty kept on the feet. This was strikingly shown in the march past at Delhi after the camp of exercise of 1885–86.

Colonel Babington recently invented a combined boot and shoe. This, however, did not meet with approval, being neither one thing nor the other, and was almost universally rejected. On the whole, therefore, I hold the best form of boot to be the ammunition boot modified to suit the native army. Special shapes should be made for them; hooks should be substituted for lace-holes in the upper part; and, inasmuch as the toes generally wear away first, an iron plate similar to that on the heel should be provided. Finally, socks or a flannel bandage should be always granted. As regards cavalry, the same form of boot with putties constitutes the most serviceable equipment.

Great-coat.

The next article is the great-coat. I hold that in the jungles of the tropics, or in the sandy plains, the soldier should never be without this article. But in place of the present regimental great-coat, I would give every man the garment known on the north-west frontier as the "choga." Made of extremely warm woollen, and, at the same time, more or less waterproof cloth, it is extremely soft and light, and adapts itself in easy folds to the body. The native tribesmen are certainly ahead of the British soldier in the matter of a campaigning great-coat.

Waterproof sheet. Blanket. Bedding.

I now come to consider the bedding. This should include a waterproof sheet.* Excellent sheets were manufactured by the Cawnpore Mills at a very moderate price during the Afghan war. Besides the imperative necessity for sleeping always with a waterproof sheet between the body and the ground, it can be employed to form a temporary *tente d'abri*; on the line of march it also forms a useful cover for the spare shirt, &c., and for the blankets when bivouacking. The waterproof sheet should never be used for a coverlet, but only for lying on.

Each man should have two blankets. In the Aka expedition only one blanket was issued; and, in consequence, greater sickness, especially as regards bowel complaints, ensued. And the blankets should be both as light and as woollen as possible. The blanket used for lying on could also have one side waterproofed. Lastly, the bedding should be exposed to the sun every day.

Spectacles.

The final article of equipment is a pair of sun spectacles, of the shape like "goggles." Not only are these an essential precaution against ophthalmia, but also, as we shall see, against sunstroke.

Concluding remarks.

In concluding my remarks on the campaigning dress, I would

* "Drill" or cotton sheeting can be made waterproof by impregnation of a solution of glue with alum.

again urge the duty of expending as much forethought on the native as on the British soldier.

Would a British regiment be sent to the front *with only one cotton suit?* And yet this happened in Abyssinia in a native regiment. Again, the bad effect of being provided with only one suit was shown in the China war on the occasion of the capture of the Taku Forts. Rain began to fall on the afternoon of the day on which the forts were taken; the camp became a sea of mud. There was unfortunately no change of clothing present. In the next eight or ten days, 200 men went to hospital, chiefly from fever and bowel complaints. I hold it is equally necessary for the native as for the British soldier to wear a suitable material next the skin. And more especially is this the case where the tropic heats of summer are succeeded by the Siberian colds of winter, as in some parts of Afghanistan. I know of one regiment which lost 200 men from exposure to the winter of Afghanistan alone. Much of the magnificent health of another regiment, the 23rd Pioneers, was due to its dress. Reported on as "the best-dressed regiment in the native army," its sick list was as small as that of any other native regiment.

General Roberts, when he took up the post of commander-in-chief in Madras, found the Madras Sepoy "absurdly clothed;" but he has now left him properly dressed, "with a uniform adapted for the requirements of a campaign." A writer in the daily Press, in advocating a better dress for campaigning for the native soldier, urged "that at least the authorities might grant the Sepoy a chest-protector." But the essential reform needed for the Sepoy is to provide him, not with a "flannel chest-protector," but with a flannel shirt in its entirety. And the same remarks may be urged for that essential part of a campaigning army—the camp followers. Let each camp follower be liberally treated as regards blankets and warm clothing.

It has been said that, in a campaign, the two great factors for producing disease are—(1) fatigue, and (2) insufficient food. "'Climatic' influences are so far secondary that they may be overcome by avoidance of one and ample provision for the other."

These indications—so refreshing in contrast to "climatic" theories of disease—were impressed on the medical officers of the Suakim force by the present Director-General of the Medical Staff. Now, in the avoidance of fatigue, a proper dress is one of the first essentials; and consequently one of primary importance against "climatic" (?) disease.

CHAPTER VI.

MARCHES.

The subject of marches in respect to malaria, sunstroke, and cholera and other diseases will be pointed out fully in their respective chapters. In this chapter I propose only to give some general remarks relative to marching in campaigns in hot climates. Thus far I have indicated the points in selection as regards material, season, transport, and debarkation. I have next to allude to marching.

Preliminary Considerations.—The soldier marches in the tropics under disadvantageous conditions as regards his heart and lungs to commence with. For it has been shown that in a given quantity of tropical air there is a less proportion of oxygen as compared with a given quantity of air in temperate climates. Thus in a given time the soldier will draw into his chest a lessened quantity of oxygen. It has also been shown that with this there is also a lessened frequency of respiration. Thirdly, in correspondence with the lessened quantity of oxygen there is a lessened proportion of hæmoglobin in the blood; there is less work for the red blood-corpuscles to do as carriers of oxygen, and hence less are required. Now, with these conditions to start with, it is at once seen that, if forced marches are immediately proceeded with on service, palpitation of the heart must come on. Moreover, all these conditions are aided by that condition of heart so physiologically described by Dr. Massy lately. He has shown how the forced continued position of expiration during the drilling of the recruit causes the "irritable heart." Such irritability he has shown to arise from the impediment to, and obstruction of, the circulation caused by the expiratory act being held in abeyance day after day on the parade ground. It is obvious, then, that soldiers thus affected are quite incapable of the work of a campaign, and a reform is needed in the process of drill undergone by the recruit.

The above considerations show how useful is the practice of route marching in India in training our men in warm countries; they also give us important indications as regards aëration on the line of march itself.

Effect of Severe Marches in Hot Climates.—Obermeier has observed that "it should be an international law to observe an armistice on abnormally hot days." This dictum, though theoretically sound, is practically unattainable. Hence we must strive to counteract the results of severe marching in tropical

climates. There are certain effects of severe marches which it behoves the army surgeon to bear in mind in warm countries. We have already alluded to the initial process of irritability of the heart which is fostered by the setting-up drill. Now, it would appear from Veale's researches that this condition is far more apt to actually come into existence in hot than in temperate climates, and more so in the tropics than the sub-tropics. Taking 100 cases, he found that 74 occurred in men who had served in the tropics, North India, and Afghanistan, 24 in South Africa, 4 in the Mediterranean, and 8 at home. These cases were examined about the time of the conclusion of the Afghan and Zulu Wars. From an exhaustive inquiry, Dr. Veale concluded that the chief influence originating the condition arose from over-exertion, with the exposure to the extreme vicissitudes of temperature, together with the marching on active service, such factors being aided by excessive smoking, fever, and intemperance. But the great fact came out that marching and exposure to the vicissitudes of such climates chiefly acted. Da Costa has also described this "irritable heart" as it existed in the soldiers during the American Civil War, and narrates how the condition begins with prolonged marches. Prof. Maclean, finally, has drawn attention to the large number of cases of hypertrophy and dilatation without valvular lesion produced in soldiers by long marches. Here, then, we have another indication given to us, namely, to so feed and clothe the body that there may be sufficient fuel for the work to be produced, and such clothing as to counteract the vicissitudes of temperature.

(*a*) On heart.

(*b*) On kidneys.

Again, *the kidneys* can become affected by severe marches. In Leube's experiments on 119 soldiers, he showed that in 4 per cent. the morning urine contained albumen after ordinary marches, but that after severe marches no less than 16 per cent. had albuminuria. Now, this temporary albuminuria will inevitably lead to organic disease if persistent causes remain. Stokvis has shown that hemi-albuminose injected hypodermically once or twice will pass out through the kidneys, but that if repeated continually it will cause organic disease of the organ. Again, Thurn has found resulting from severe marches, especially in the heat, hæmaturia, strangury, and formication. Finally, in a paper read at the Copenhagen Congress, Dr. Laub showed how fatigue in untrained soldiers set up *periostitis* of the lower extremities where there had been a too short period of training in marching.

(*c*) On lower extremities.

I have adduced the foregoing exposition in order to show how essential it is that on the entrance of a campaign the marches should not be excessive. The men must be gradually trained for severe marches; otherwise both the external and internal organs of the body so necessary for marching will break down. I proceed now to consider the points in the conduction of marches in hot climes—(1) to obviate the occurrence of fatigue, and (2) to favour the aëration of the blood, for it seems to me that these are the two great ends to be borne in view in marches generally. These ends secured, they will naturally also help to ward off

such special accidents occurring on the line of march, as sunstroke, &c.

Period for marching.

The period of choice for marching is important. I shall point this out later on with regard to special diseases, but meanwhile it may be said that in hot countries, both on general and on special grounds, the march in the early hours of morning is indicated.

Bad effect of night marches.

Night marches destroy the men's rest. By night marches I mean marches undertaken as night falls, *before* the men have had their sleep, such sleep being only allowed when the march is finished. For it is but a poor rest that our men get by sleeping in the day in their hot tents. The cooler night should ever be utilized for recruiting exhausted nature. The French in Algeria tried night marching, but soon found their hospitals filling with men suffering from the strain induced by it. Personally, far greater fatigue has been experienced during night marches than during day. On the news of the massacre of Cavagnari at Cabul, my regiment, with two others, was ordered to seize the Shutargardan Pass as quickly as possible. On the first day we marched 16, on the second 15, and on the third 18 miles, but no excessive fatigue was experienced. On the night, however, following the last stage, we were ordered suddenly to finish the remaining 6 miles, as the Pass was reported to be in danger. This night march, short though it was, caused far greater fatigue than any of the preceding. In this respect, then, let the rule of our German *confrères* be religiously observed: "Aus der Nacht in den Tag, und nicht aus dem Tag in die Nacht."

Economy labour.

Having thus settled the hour of marching, let us next consider the question of economy of labour on the march. Now, experiments on muscular action show that the more a muscle is in action the sooner it gets tired; if, moreover, a muscle is kept in a condition of continuous tension, it loses its strength more and more; waste products are continually given off without any corresponding reparation, until at length its function ceases. Thus a muscle for its reparation needs periods of rest corresponding to periods of work. Hence also it follows that labour is more economized by working for short periods with frequent short periods of rest, than by working at a long stretch with only one period of rest. Now, applying this to the muscular action of marches, frequent short halts are better than one long halt. Moreover, if a very long forced march is in view, then the halts should be short and frequent at first, gradually increasing their length as feelings of fatigue come on. A given distance is, in fact, better got over, with regard to economizing force, in small sections with short pauses than in large sections with long pauses. As we shall see, this principle was adhered to in General Roberts' march. So much may be stated as regards marches generally, but in the tropics we have, in addition, the element of a high temperature to account for. In experiments on muscle it is found that at a temperature of 46° C. the myosin coagulates and then undergoes retrogressive metamorphosis, until the whole of the substance of the muscle becomes disintegrated. But in the human organism, under the

action of a high temperature, changes occur in the nervous system rendering secondarily the muscles incapable of work before the temperature has reached so high a grade as to cause coagulation of the myosin and its sequelæ. This influence on the nervous system causes the innervation of the muscles to be damaged, and thus the muscle gets weaker and weaker. Thus, then, we see in excessive marches the mechanical work, if not compensated by reparation, can but result in loss of function; whilst as a result also of excessive high temperature, the function of the muscle ceases. We have therefore a twofold action to guard against. The question of temperature will be more particularly dealt with in the chapter on Sunstroke; the question of labour must be met by more frequent pauses, and more prolonged rests on the line of march in the first instance.

Conduction of a march.

With these preliminary observations, I am now in a position to point out the various indications on the line of march. To repeat, the two great general indications are—(1) to obviate fatigue as much as possible, and (2) to obviate hindrances to the aëration of the blood as much as possible; whilst the third indication—special—is to obviate rise of temperature and heat-stroke. The latter will be fully treated farther on; meanwhile, I must enter into it somewhat here.

Chota. Haziri.

Before the men start, then, let them have a good ration of bread, coffee or cocoa, &c., and their antiperiodic ration. Next,

Pace.

let the pace not be too slow; nothing can be more fatiguing than a very slow march. Moreover, there is a certain pace combining the quickest going with the least resistance. Thurn puts this at about 100 steps per minute, and states that at this rate the leg pendulum traverses its full swing. At a less rate the swing is not completed. The rate of 100 per minute will combine the least expenditure of muscular force with the highest number of steps per minute. The pace of marching is most important with reference to fatigue. The leading regiments must not exceed this pace, for, if otherwise, the rear will have much difficulty and fatigue in keeping up with them.

Open order.

Next, the most open order must be carried out, so that the air round each man be ventilated as much as possible. It is advisable, indeed, that the men should, where the road permits, march in two parallel bodies in open order on the sides of the road, leaving a clear space in the middle of the road. If the ranks march close up, then the temperature in the ranks mounts up; respiration is hindered by the accumulation of CO_2, and the conditions for sunstroke favoured. Let their coats be open, all collars unbuttoned, and nothing superfluous carried. Dr. Lewtas, of the "Guides" in the Afghan war, arranged for mule carriage always to accompany the regiment; the mule carriage kept pace with the men, and so arrived in camp with all their necessaries; on no occasion had they to wait for their change of clothes.

Halts.

The rationale of halts has already been laid down. Let the halts be ordered so as to take advantage of any shade. As we shall see in "Sunstroke," let the men not lie down on the hot

earth when halting in the open. This, however, does not apply to marching in damp hot climates, like those of the north-west frontier. Here it would be preferable to halt in the open, and to put on the great-coat whilst halting. This was inculcated in Looshai; where neglected, it was found to predispose to "fever" and dysentery.

A little over half-way, arrangements should have been made previously for breakfast. The men will have prepared their provisions and carried them; but at the appointed place coffee should, when possible, be found ready for them, and a fair meal be obtainable. Food.

The regulation of fluids on the march is most important. The conservative power of the eliminating function of the skin against excessive rise of temperature is well known. This function of the skin must be assiduously attended to. It follows that, if the body contain too little water for the necessary amount of perspiration, the secretion will be diminished, and with this the body temperature will rise. The mere mechanical act of marching raises the body temperature; how much more, then, will it be raised when the giving off of heat is stopped by insufficiency of skin function! It was formerly held to be dangerous to drink when hot; drinking a large quantity of very cold water certainly may be dangerous from shock to the solar plexus; but drinking small quantities at intervals is quite the reverse. For this reason Thurn advises rather that the men should drink whilst actually marching than during halts. The value of a continuous supply of small draughts of water as a prophylactic against sunstroke will be shown in the proper place. Meanwhile, Dr. Smart, of the army of the Potomac, may be quoted: "If the water in the canteens lasted until the next opportunity of refilling them, so that ingestion and transudation were equalized, the men pushed along, faint from fatigue perhaps, but in no danger from sunstroke. If, on the other hand, the supply failed and the skin became dry, danger from sunstroke was imminent." Let, then, the regimental bheesties be at hand with their mussucks. Let the men also have their water-bottles filled with cold tea for the march. The conservative action of the skin will come into play, of course, far more where the atmosphere is dry and hot than where it is moist and hot. In the latter instance, every opportunity, when halting or otherwise, should be taken to bathe one's face and hands. Liquids.

Alcohol should, in the shape of spirits, never be given on the line of march. Instances of the fatal effect of such procedure will be found in the chapter on Sunstroke. Red wines, where obtainable, are, on the contrary, to be recommended, especially in cholera and dysentery times. The inclusion of such wines in the food supplies for the Egyptian operations of 1882 was a great step in advance. Alcohol.

Get all stragglers out of the way as soon as possible. During long marches the sight of men falling out has a bad effect on the morale of the men. This fact was recognized and provided for in the Saxon army in the Franco-German war, each regiment being Stragglers.

supplied with carriage, especially for those who were compelled to fall out. Similarly, in General Roberts' famous march, pony and donkey carriage was provided.

Rains.

In the rains, unless military necessity compel it, the men should not travel; where they are obliged to, let them at once dry themselves and change their clothes on arrival in camp, and have some quinine and food as soon as possible. As soon as the march is over, let the men be at once dismissed. Thurn urges that standing at ease in the ranks after a long march is more fatiguing than ordinary marching itself, and gives instances of syncope and sunstroke occurring in a case where the men were kept standing for a long time after a forced march, no such attacks having occurred during the march itself. On dismissal, if possible, the men should wash their feet and as much of the body as circumstances permit. Attention to the skin is of the greatest importance in preserving the individual from the ill effects of hard labour. On sultry days all precautions should be doubled which tend to promote evaporation. Frequent bathing of the face and hands is indicated. In my experience, incipient symptoms of sunstroke have been warded off by the application of a mussuck during very hot marches in Afghanistan.

Dismiss men at end of march quickly.

Medical supervision.

Finally, the regimental surgeon must be on the look-out for signs of fatigue, failure of the heart, sunstroke, and the various forms of vaso-motor neurosis, so that the men may be at once directed to fall out and get timely preventive treatment.

Illustrations.

Nowhere is the preventive art of marching better illustrated than in India. And the lessons learnt in peace naturally bear fruit in war. Thus in Egypt in 1882 the health of the Indian contingent was greatly enhanced by the excellent arrangements carried out. The 72nd Highlanders, fresh from the experience of the Afghan war, had arrangements that were the envy of the regiments of the home force. The native corps of water-carriers, sweepers, and dooly-bearers were invaluable, and rendered most welcome assistance to the home regiments.

General Roberts' march.

The finest illustration of a perfectly managed march, however, is to be found in General Roberts' march from Cabul to Candahar. Every arrangement, in its minutest detail, was provided for. It may be well, therefore, to mention a few of the arrangements. In this march a force of 10,000 fighting men covered 303 miles in 20 days, giving an average * (including 1 day's halt) of 15 miles per day.

The hospital returns for the force of 10,000 combatants and 8000 camp followers were at the end of the march, at Robat, 68 Europeans, 448 Sepoys, and 291 followers only. And, finally, the force the day it entered Candahar executed a reconnaissance in force, whilst the day after it fought the final battle of the war, and defeated Ayub's army flushed with repeated victory. The publicly expressed criticism in England previous to the undertak-

* From Ghuzni to Khelat-i-Ghilzai for 8 days they covered 17 miles a day.

ing, that the march was against all rules of war, and that disaster was thereby inevitably courted, was thus shown to be singularly unfortunate and unjustified. The weak point in the force was provided for. General Roberts discarded all camel transport, using only mule and pony. He also, by a special order, impressed on all the necessity of proper feeding and adjustment of the loads. The time of the year was propitious for supplies, fruit and corn being abundant. The march began on August 9; Robat was reached on the 28th, 18 miles from Candahar. The troops were picked men, and moreover improved in health daily, with the exception of some unseasoned, recently joined men of the 72nd.

Though the season of the year was becoming more propitious, the nights being cool, yet the heat in the day was very great. The alterations of temperature were great. At the "rouse" a cutting wind and a low temperature would often chill the men, to be succeeded as the day wore on by a burning sun, sand storms, and suffocating dust, to alleviate the effects of which, water was often absent. At times the temperature in the tents reached 102° F.

An idea of the work may be gathered from the fact that the regiments forming the main body had, after their long march of perhaps eight hours or more, on arrival in camp, to furnish parties for all kinds of duty—fatigue, foraging, guards, sentry-go. The rear-guard often would not reach camp until 9 P.M., having been worked since 4 A.M. that morning.

But no precautions were omitted. We have seen the order concerning the transport. In the same way the men's rations were increased to 1 lb. 8 oz. meat daily, whilst each native soldier and camp-follower * was ordered 8 oz. meat daily in addition to his ration. Donkeys and ponies were provided for the men who fell out. A general order thanking the force for its exertions was published at Khelat-i-Ghilzai, and the honour of relieving the garrison was held out to the eager force in inspiriting periods. The General also would ride back to meet the regiments marching into camp, although suffering severely from fever himself, thus ever evincing his solicitude for all. And thus it was that the force arrived fit to fight the last battle of the war on the day after its destination was reached.

In conclusion, let me point a few of the facts of this march.

Selection of Troops.—As I have before said, with one exception the men were seasoned soldiers.

Season.—The heats of summer were on the wane, the nights being deliciously cool; still, the day heat was excessive.

Hour of Marching.—At first at 4 A.M., but here was shown in many instances the oppressive effect of a march throughout the day; subsequently the hour was altered to 2.30 A.M. The rear-guard of the day always arrived in camp most exhausted of all. The chief hardship on the march was the want of sleep.

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* This was essential for the camp follower, as he began to get knocked up from the work.

On arrival in camp late, so much had to be done that comparatively little sleep could be obtained before the *reveillé* again aroused the men.

Halts.—The labour was economized by adopting the principle of frequent short halts. At the end of each hour a ten minutes' halt was ordered, as well as the breakfast halt of twenty minutes at 8 o'clock.

Arrangements for Men falling out.—Note also that arrangements of pony and donkey carriage were made for all who fell out. The cases were few indeed in the fighting force, fired by emulation, but at one time were a source of anxiety amongst the camp followers.

Food.—Extra meat* rations were given to the British troops, whilst a meat ration in addition to the usual one was issued to the native element. The general arrangements of the commissariat for food were excellent. Bread was generally distributed daily, and in no instance did a soldier or follower fail to receive his rations.

Finally, the hardest days of all were on the 19th and 20th. And the hardship was caused by the want of water. The march on the 19th of August of $14\frac{1}{2}$ miles was indeed more severely felt than the march on the 20th of 21 miles. Water was so scarce that the followers fell exhausted on the road. The heat, too, seemed greater than ever. After the experience of these two days, the men marched at 1 A.M. to escape the heat of the day as much as possible. On the sixteenth day the men enjoyed one day's halt, and the day was spent in sleep by all who were free to enjoy it.

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* The British ration was increased to 1 lb. 8 oz.; the native had 8 oz. meat given him.

CHAPTER VII.

CAMPS:—SITES—VENTILATION—CONSERVANCY—NIGHT DUTIES—LIFE IN CAMP—BATHING PARADES, ETC.

In treating of the subject of camps, we enter upon one of the most important elements in connection with the health of the soldier. "War," as Dr. Guy has pointed out, "is in its essence a conflict of crowds," and consequently the factor of overcrowding is a factor constantly working against the efforts of the army surgeon. And this factor of overcrowding must come into play with far greater force as regards its consequences in hot climates, for here the results of overcrowding in the shape of accumulated excreta from the alimentary canal, the skin, the lungs, &c., will be acted upon by tropical heat.

In treating of camps, the subject naturally divides itself into temporary and permanent camps; the rules for temporary camps apply with still greater force to permanent camps. I shall first indicate briefly the question of sites; then the questions of ventilation and conservancy; and, finally, questions concerning the life in camps.

Sites.—The choice of site is naturally more important for permanent than for temporary camps: a bad site may be chosen to pass a single night in, and then to be left next day without, it may be, much harm; this would not be the case as regards a permanent camp on the line of communication. Here if at first a bad site perforce have to be chosen, it must be evacuated as soon as possible for better ground. The relation of camps to specific diseases will be found in the proper places, especially in the chapters on Malaria and Bowel Complaints; whilst the relation of soils to absorption of heat will be found under Sunstroke. Here I give shortly a review of the different sites that may meet a campaigning army.

First as regards unfavourable sites. The following are to be avoided where possible:—(1) Valleys so narrow that the air stagnates; (2) entrances to gorges; (3) foot of hills, especially where the water descending from them has stagnated; (4) depressions in a general plain with stagnating water; (5) embouchures of rivers; (6) half-dried beds of rivers; (7) jungly ground on banks of rivers and lakes; (8) ground immediately above marshes; (9) ground exposed to winds blowing over a neighbouring marsh; (10) dry beds of tanks, ground below the bund of a tank; (11) forest clearings. On the contrary, the following constitute good sites:—(1) All high and dry grounds, especially where Unfavourable sites. Favourable sites.

there is a natural slope descending, so as to carry off moisture; (2) tongues of land jutting into the sea; (3) slopes of hills; (4) banks of running rivers not in the neighbourhood of marshes; (5) grassy country; (6) under trees; (7) ravines through which a healthy breeze from a mountain chain above them blows constantly. Sir Ranald Martin observes, however, that, with respect to Negro troops, a residence on high ground is "fatal."

Geology. As regards the geological structure, sites on granite, slate, limestone, and chalk unmixed with clay are good. Should, however, marshes be present on the limestone, such a soil is to be avoided. Even an originally healthy chalky site may become pestilential where the ground is flat, and has consequently become charged with excrementitious matters. Permeable sandstones are exceedingly healthy also.

The following soils are, on the contrary, to be avoided:—Disintegrated granite; sands mixed with clay, or with clay subjacent; sands incrusted with vegetable *débris*: clay soils; alluvial soils, especially where such soils are composed of sand and clay alternating with each other and impregnated with alluvial matter, such as are found in the deltas of rivers and their neighbourhood. Martin suggests that ferruginous soils by chemical decomposition may be productive of malaria, and instances the "destruction" of the army of General Morrison in the first Burmese war of 1825. This column was operating on a range of hills composed of sandstone mixed with ferruginous clay.

Summary. As regards the geology and conformation of the features of any locality, the chief points to bear in mind are—(1) *The water supply.* The water supply in the favourable geological sites is, as a rule, good. (2) *The drainage.* A good natural drainage is essential for the health of a camp. Dampness is by all means to be avoided. Dampness of soil adds immensely to the liability to "camp diseases"—fevers, bowel complaints, and the like.

Brushwood, jungle, &c. The relations of trees, brushwood, and undergrowth will be fully entered into in the chapter on Malaria. Recent experience has indicated that the views held previously concerning these natural features must be modified.

So much, then, for some of the principal rules as regards conformation and geology of sites. I will now illustrate them from actual campaigns.

China, 1860. In the China war of 1860, preparatory to the advance, the troops were collected in a standing camp at Kowloon, near Hongkong. The surface of the ground was dry and undulating, and open to free circulation of air from whatever direction the wind blew; the water supply was good. In some neighbouring ravines, it is true, were patches of rank vegetation, yet, from the prevailing wind, all chance of malaria was avoided. In addition to the above natural features, the camp was on a promontory and open to the sea breezes.

In Looshai the camps in the lowlands during the advance were again very unhealthy; the forest trees dripped constantly with water, until the sun for a few hours was sufficiently powerful to dissipate the mist; then, as evening came on, the mist would again collect. But as soon as the highlands were reached the air was found dry and bracing, and the camps enjoyed a comparatively open country. Looshai, 1871–2.

In the Duffla expedition several of the sites on which it was necessary to pitch camps were very bad. Thus at camp No. 6 the soil was swampy and full of decayed vegetable matter; the forest so dense that the sun was only visible for four or five hours. Damp, cold, penetrating fogs would often arise. The survey officers attached to the force reported, indeed, that the country would be deadly in the hot and rainy seasons. Duffla, 1874.

In Afghanistan, the camps in the Kurram Valley were generally thoroughly exposed to the wind blowing down from the Safed Koh range; the valley was wide, and the camps constantly perflated. Afghanistan, 1878–80.

During the Zulu war a camp was established and a fort built, named Fort Chelmsford. The situation was most unsanitary; marshy; with water supply organically impure from contamination by dead cattle and slain Zulus. The bowel affections became so rife that the sick had to be evacuated. Zulu, 1879.

At Ali Kheyl, on the farther side of the Peiwar Pass, a large camp was formed on two tongue-shaped plateaus jutting out from the rolling uplands descending from the Safed Koh range into the broad bed of the river. There was magnificent ventilation, and good natural drainage. The plateaus were separated from each other and from their lateral neighbourhoods by deep ravines. I was encamped here during May and June, and the heat was greatly brought into subjection by the free perflation of air. From this camp I was transferred to another, situated at the top of a ravine at right angles to the general direction of the Kurram Valley. The tents were pitched under pine-trees, and down from the snowy summits, some 6000 feet above, came ever a breeze. Another tent camp was pitched on the summit of the Peiwar Kotal in the pine forest. Again, as cholera invaded the valley step by step, the various regiments removed their camps to the flat spurs jutting from the mountain chain into the plain. These likewise were thoroughly perflated by the mountain breezes. But at Thull, at the immediate entrance of the Kurram Valley, the site of the camp was more shut in; the sides of the valley were approximated, and the camp lay immediately under the hills on the right hand. This camp was certainly the hottest of the whole line—at a lower level, it is true, but the lower level was combined with more confinement.

Turning now to the Candahar side, as far as the Kojuck the camps from Quetta were on a dusty, sandy plain; the heat, consequently, was terrible; the experience of 1885 in the lower Bolan in the hot weather has again testified to the danger of heat-

stroke that troops occupying the line must ever encounter. And in correspondence to the character of the locale was the drinking water. Instead of the pure water from mountain streams in the Kurram Valley, the troops had to drink the saline waters from underground karezes in the Pishin Valley. And as regards drainage, the flat superficies of the Pishin Valley was admirably adapted for the formation of a nursery bed for enteric fever; the disease, once introduced, speedily became rife along the Candahar line. No contrast could have been greater than the conditions of life in the Kurram and in the Pishin Valley.

Aka, 1883. In the Aka expedition, the forest country traversed was very unfavourable for camps. Forest clearings as a rule are confined and unhealthy, the nearness of the surrounding forest rendering ventilation difficult. In Aka land, it was found far preferable to encamp near the main stream than in clearings, for along the stream would roll a healthy current of air. At the third march out, however, at Digumubh, a suitable place was found for a large camp, consisting of a fine open site, some distance from the forest, and with abundance of good drinking water.

Ventilation of Camp.—I now come to the important subject of the ventilation of the camp. Under this I include, not only the ventilation of the camp generally, but of the tents and of the ground on which the camp is pitched. The ventilation of the ground is also interwoven with the question of conservancy. It may be well to show the direction in which camps influence health in the tropics at the outset.

Now, war, as we have seen, is the bringing together of crowds. Thus, at the very beginning, the question of ventilation comes on. And inasmuch as we cannot have war without crowds, so every expedition must carry with itself predisposing elements of disease. Nor is it necessary for disease that there should be overcrowding with these crowds, for Prof. Du Chaumont has shown by tables "that the mere bringing together of a number of people into a community, even when there is no excessive crowding, is in itself a source of danger," and "that the mere aggregation of human beings exercises a powerful influence on their health and vitality." By this aggregation both the air and the soil are affected, and therefore the ventilation of a camp must include both ventilation of the air and of the soil—and, for the reasons before stated, all measures indicated in these respects for camps generally are still more demanded for camps in hot climates.

Air. Tents to begin with are but little pervious to air, and, when wet, nearly impervious. The organic matter given off from the lungs, as is well known, does not tend to diffuse itself, as do the gases given off from the lungs; hence the mere opening of the doors of the tent does not act so beneficially as regards the organic matter as it does with respect to the carbonic acid. The organic matter tends to attach itself to the walls of the tents and to their contents, whilst, finally, the greater the number of men in a tent the greater disproportionately is the rapidity of increase of

aërial impurity from this cause. A space of double the size with double the number of men is less healthy than a space of half the size with half the number of men.

Now, the limit of respiratory purity is 0.2 per 1000 of CO_2. Prof. Du Chaumont shows that 1 man in 50 cubic feet would bring the amount of CO_2 to this limit in 1 minute if this space were unventilated, or in 36 seconds if there were only 30 cubic feet. 50 cubic feet is the space per man in a bell tent with only 10 men, and 30 cubic feet the space with 18 men. In the Afghan war, pâls were used by the Bengal force; by the Madras regiments, a tent peculiar to the Madras army.

The scale of camp equipage in the Bengal troops was 22 men to 1 tent composed of 2 pâls; for native troops, 44 men to 1 tent of 2 pâls. Here, therefore, the authorities, to begin with, evidently judged that the native soldier either only gives off half the respiratory impurity of the British soldier, or is so peculiarly constituted by nature as to require only half the amount of ventilation. No wonder, then, that—as will appear in its appropriate chapter—infectious pneumonic fever prevailed on occasion. But more than this: 40 Sepoys in time of peace go to 1 Sepoy tent of 2 pâls, so that in time of war the already insufficient space was decreased. As regards the superficial space thus granted to each man, the Madras tent gave to each British soldier 12 superficial feet.

The Bengal tent (32 feet × 16 feet wide = 512 square feet floor space) gave to each British soldier a little over 23 square feet, and half that space to every Sepoy; thus the Sepoy had on service actually less square feet than are given to coolies on the transport vessels of the Assam rivers, for whom 12 feet square are laid down as the minimum. Granting that the British soldier cannot from want of transport receive more space, yet surely what is necessary for him is necessary for the Sepoy, especially as we shall see he is liable to epidemic pneumonic fever, this liability being actually experienced in the Afghan war. The effect of overcrowding was strikingly shown in the China war of 1860 at Talien-whan Bay. Here the village set apart for the coolie corps was greatly overcrowded. Sickness at once arose, and some 300 men had to be left behind when the expedition sailed. Sickness from the same cause arose in the camp of the 60th Regiment. Such being the conditions of tentage allowance, we at once see how necessary as a rule it is never to close the tents. The horrible fœtidity of the air that arises in an extremely short time need be experienced once only in order to recognize the necessity of this rule. Add to this the inherent tendency of the native soldier to roll himself bodily up, head and all, in his blanket, and we can see how in his case the conditions are aggravated.

An important guide on this point was furnished by the present Director-General to the medical officers proceeding to the Soudan, as follows:—

Square Yards per Tent.	Tents per Acre.	Troops per Acre at 12 Men per Tent.
50	96.80	1161.6
100	48.40	580.8
400	12.10	145.2
1000	4.84	58.0

This table shows the extreme limits from great overcrowding "to what would be an impracticable, though desirable, amount of space." The question of tentage allowance is the question of transport allowance; and to a rich country like England money spent on transport would be wise economy, for it is evident that whatever preserves the health of the soldier on campaigns repays itself many times; a seasoned soldier may be invalided from preventable causes, and his place taken by an immature, unseasoned youth; then, added to the expense of the move, we have the fact of a bad exchange. Against the larger supply of tents, however, on the other hand, we have the hampering thereby of military movements; but here common-sense can step in; when the foe is imminent, the troops can then double up in light marching order, as was done on the march to Cabul, when two officers shared one 80-lb. tent. For troops, however, on the line of communication, larger tent allowance is indicated in the tropics. Prof. Du Chaumont has shown that "the most open order of camps in war time gives a much smaller space per head than the most crowded conditions in civil life, and camps may be so compressed as to give only 8 square yards or less per head." But, nevertheless, provided the tents be kept open as we shall presently indicate, the conditions are not quite analogous, for the air itself of crowded towns, to begin with, is immeasurably more impure than the air of a camp in the open. So that, though the individual space should be increased, much may be done by so arranging the camp that the prevailing wind perflates it, and by insuring that the tents be kept closed only so far as to prevent the blazing sun pouring in. And in this matter we see how important it is that the site of a permanent camp should be such that the air can freely circulate all over the camp.

Soil.

Let us now consider the factor of the soil. In like manner as too many men aggregated in one space will infect the air so will they infect the soil, and with this infection will appear bowel complaints, and the specific diseases, cholera and enteric fever, when the specific element is superadded. Under every precaution organic matters are thrown out in camp, and by intercourse pressed into the soil, and thus gradually the earth becomes infected. And in hot countries under the heat and rainfall the process becomes much more acute, especially where the soil itself does not possess any disinfecting power. Sandy soils, for instance, act prejudicially both by not disinfecting these organic matters and by their drying power, so that when clouds of sand are raised by the wind, these clouds contain in suspension organic matters. It is thus easily seen how both the alimentary and respiratory

passages can admit poisonous materials into the system. Added to the organic matters proceeding from the men, we have those also proceeding from the animals in camp. Of the above infection of the soil we have many examples in campaigns. In the New Zealand war of 1864, after the occupation of Waikato, several Government surveyors were employed, and whilst they constantly changed ground they kept in robust health. After a time, owing to eventualities, they were obliged to remain pitched in one place near the troops, close to the Land Transport camp, which was especially dirty. Bowel complaints speedily began to affect the majority of the survey staff. On their again being able to move about, the bowel complaints ceased. New Zealand.

In the Zulu war, the first division, operating on the coast line, was kept stationary for a long time in camps which gradually became more and more unsanitary from the presence of men on the same spot, especially of the native troops. The large number of oxen also added their quota to the general mal-hygiene. Zululand.

In the Kurram Valley, as far as the camps coming under the notice of the author were concerned, the tendency to become unhealthy was kept in abeyance. A special officer in each camp looked after sanitation. But in the Pishin Valley the contrast was great. The soil was exceedingly loose, and regularly each day, from 10 A.M. to 6 P.M., a dust storm would blow through the camp. At Kila Abdoola the *mauvaises odeurs* were profound and searching, and it was apparently no one's business to look after them. The contrast between the healthy breezes of the Kurram camps and the fœtid smells of those in Pishin could be perceived even by the most anæsthetic Schneiderian membrane. Afghanistan.

Finally, in the Nile expedition 1884–5, the camping grounds in the desert became rapidly fouled in spite of all precautions, owing to the accumulation of large bodies of men in a circumscribed space. Egypt.

Thus, then, in camp we have to ventilate both tents and ground, for in hot countries the men must remain for many hours of the day under shelter from the sun; in temperate climes they can sit outside their tents, and thus breathe unrestricted the pure air, but this cannot be done in hot climates during the hot hours of the day.

First, then, as regards the ventilation of the tents. In all the service tents that I have seen there has been one great omission, and that is in the absence of proper outlets for impure air at the top. Occasionally there have been openings in the sides of the tents, but of so small dimension as to be useless. All pâls should be double fly'd, and on the summit of the inner fly there should be a large opening at intervals along each wall. On the outer fly, but at intervening spots, there should be similar openings. Secondly, the fore and after doors should always be open. Thirdly, with the exception of the periods of the day when the sun is overhead, the side of the tent away from the sun should be raised. Let the kanats be raised at all events; a current of air will then be directed from outside upwards to the above-mentioned outlets. Tent ventilation.

At night, one of the doors should be opened. During the American war this was rigorously enforced, an officer of each company being told off to see that this was done. Finally, the men should sleep with their heads towards the walls of the tent, so as to catch the fresh air entering it, and not towards the middle, where they would be bathed by the ascending impure air. Should it be deemed advisable at night to raise one wall of the tent, let that to leeward be raised.

Soil treatment.

Turn we now to the treatment of the soil. In the first place it must be beaten down as much as possible, so as to render it less permeable. In the Afghan war I had my hospital floor coated over with earth. This mixed with water and plastered over makes an exceedingly cleanly floor, easily swept, and easily renewed. Again, at Ali Kheyl there was an abundance of pebbles; these also made a fair flooring for the men's tents. Whatever be the means, however, whether pebbles, beaten earth, &c., the floor must be scraped and renewed at least once a week. All ashes should be utilized in flooring. Next, to still further dry the earth, each tent must have a drain cut round it, joining the main drain of the street.

Ventilation of soil and tent.

Lastly, once a week all tents should be struck and aired; this proceeding will of course equally air the ground. On the days appointed for striking the tents, let the floor be scraped and the past week's flooring removed. Then, after the airing is finished, make the new floor. Once a week is the least that should be allowed; should there be time, every other day is indicated for striking camp.

Now, all the above indications can be carried out in any camp. There are, in addition, two courses to be followed out when occasion and locality permit—first, to move to fresh ground periodically; and, secondly, to pitch the tents as widely apart as possible.

Hospital tents.

With regard to hospital tents the ventilation of air and soil is equally imperative, whilst it would be advisable to pitch the tents *en échelon.*

The camp itself should, in addition, be regularly drained by surface drains in accordance with the lie of the land. It is of extreme importance in the tropics to render all camps as dry as possible, thus limiting fermenting processes; the driest spots are to be chosen.

Conservancy of Camp.—I shall here only allude to the conservancy of the camp as regards rubbish, scrapings of tent floors, of camp paths, &c. The conservancy of the excreta, and measures relating to dead animals, will be alluded to later. All conservancy must be most rigorously attended to in a hot moist climate, for any defect which might not result in evil consequences in a hot dry climate, will inevitably bear fruit in a hot moist one. There should be a special sanitary officer in each camp. Night and morning all paths and insides of tents should be regularly swept. The refuse should then be collected, carried to leeward, and burnt; what cannot be burnt must be disinfected and buried.

Prof. Du Chaumont has proposed that supplies of petroleum be carried for this purpose, whilst others have laid down that all permanent camps should have a portable iron furnace. I very much doubt, however, if sufficient transport could be provided for these ends. In the Zulu war, dust-barrows were extemporized by attaching sticks to the sides of small empty packing cases obtained from the commissariat, and ingenuity will suggest many such devices.

Tents.—The subject of tents is entered into fully in the chapter on Sunstroke. A few remarks only are necessary here. The tent, both for Europeans and natives, should have a double fly. The usual tent is lined with a flaring yellow cloth; this makes the interior seem far hotter than if a dark-blue lining were fitted. I saw an excellent tent that had been brought out from England from the Inventions Exhibition; made by a firm in East London, it was an exact model of the 80-lb. Cabul tent, only that the weight was only 40 lb. The extra weight was got rid of by the substitution of wooden pegs for iron, and of canvas for drill. It was perfectly waterproof; the waterproofing material, moreover, gave a light-green colour to the canvas, most refreshing to the eye. I saw the tent the morning after one of the heaviest storms of the year, and the inner side of the outer fly was perfectly dry. Now, surely some such material could be utilized for a double-fly pâl; half the weight would be saved for other purposes; the men would have a double fly, and would have a tent presenting a most refreshing tint to the eye dazed by the heat. Such a tent also would not be conspicuous by its colour. The bell tent is utterly unfitted for exposure. This was shown in the China war. At Talien-whan a large amount of sickness arose, principally dysentery; yet the site was healthy, and the men had been selected. The lowest number of sick were in the 99th Regiment, and this regiment alone had not the bell tent. Dr. Rennie recommended a reduction of the number of men in each bell tent, but such reduction was not sanctioned, owing to military reasons.

In Suakim, 1885, the single-fly Lancer pâl after May became too hot from the midday sun in the follower hospital, and would have been quite unfitted for its purpose if it had been used later on in the hot weather.

Again, in the fighting column in 1885 bell tents were found quite unfitted for the climate.

In camp, also, the men should sleep off the ground where possible. Some arrangement like that in Turner's tent should be settled so that the men may be raised off the earth when sleeping. There is not the slightest doubt but that improvement as regards weight, ventilation, and heat is required. The various contrivances as regards heat will be detailed in the chapter on Sunstroke.

During the last year trials have been made at Aldershot of the Doecker tent, made of felt on a frame-work of wood. Their weight, however, would seem to preclude their use in war. Some, however, were sent for use as ambulance huts to Egypt in the late war, and the Doecker hut at the international competition

for ambulance huts at Antwerp in 1885 took the prize out of 80 different competitors. The essentials of a tent for the tropics are the following:—

1. Waterproofness.
2. It must have a double fly.
3. Both flies must be ventilated by *large* outlets near the roof, alternating in position on the flies.
4. The colour should be refreshing to the eye, and at the same time not conspicuous to the enemy.
5. It should be as light as possible. The lighter it is the larger number can be carried, and the larger, therefore, will be the individual space allowed to each soldier.
6. The outer fly should be a sack, capable of being filled with grass, where occasion serves, and thus to act in warding off the heat of the sun.

Such tents could be made of the material of the tent I have described.

Hutting.—Before proceeding to remark on a few points connected with camp life, mention may be made of other conditions in which the soldier finds himself in camp in tropical campaigns. For instance, in many of our expeditions, as in Ashanti and the north-east frontier and Suakim, excellent bamboo huts were made. The chief points in building such huts are here again connected with ventilation. Thus, raise the floor on piles so as to allow free perflation of air beneath. Let the walls be double, with an intervening space, a space being left at the bottom of the inner wall and at the top of the outer wall. Provide for thorough ridge and end ventilation; also for side ventilation by side windows. Great attention must be paid to the roof to render it perfectly watertight, and hints can very often be obtained from the native huts in this direction; thus, our men found the roofs of the native huts in Ashanti very steep with a view to throwing off the rains. The men should sleep inside on platforms raised around the walls about two feet from the ground. By economizing their waterproofs some could be spread over the roof; or, the bark of trees peeled off, laid on to intercept the rains. The walls can be easily extemporized, should there be not enough wood for them, by matting, leaves of palms, &c. Bamboos, when obtainable, form excellent materials for hutting in the tropics. Arrangements for sleeping *off* the ground should also always be made.

Ashanti, 1873. In the Ashanti expedition an excellent series of hutted camps was formed under the direction of Sir Anthony Home. The walls were made of split bamboo, admitting free ventilation, protected at night by matting. The floors, made of rammed clay, raised one foot from the ground. In each stationary camp, huts, each to lodge 65 men, were made (70 feet long by 17 feet broad). On each side of a central passage were the beds well raised from the ground. These huts were erected on the road from the base to the Prah, and it was arranged that successive detachments, 400 strong, should pass up daily to the point of concentration at the Prah.

In the Looshai expedition excellent huts were erected. Their form will be found figured in the *Med. and San. Report of N. Army of Bengal* for 1872. Bamboo sheds are said to have been erected, housing all the troops within an hour after arrival in camp. Looshai, 1871-2.

Again, in the Malay expedition bamboo huts were built, so arranged as to give each man 260 cubic feet of space; but this small space was compensated by the free ventilation through the walls. Along the walls, bamboo platforms were constructed for beds, 2 feet high. Malay, 1875-6.

At Aka, again, our men hutted themselves; the same general plan was followed out. Aka, 1883-4.

In the north-east frontier country, indeed, there will generally be found plenty of material for hutting, and, provided there be plenty of ventilation through the walls, the small space for each man will be amply compensated.

Villages.—The third and last condition of habitation allotted to the soldier in campaigns will be that of deserted villages or towns. In these cases, especially, much sanitation will be necessary before occupation. Look, for instance, at the state of the huts in Rangoon in the first Burmese war; again, at the condition of the houses at Cape Town, Gold Coast. Here were a series of closely packed, unventilated buildings, surrounded by refuse of all kinds, with stagnating drainage, ordure deposited anywhere, and the whole acted on by a tropical sun. No wonder the first troops suffered from inordinate sickness. Again, how much cleansing was necessary at Cairo before any of the buildings could be occupied. Owing to the filthy condition of the palaces and buildings, this could not be perfectly carried out; had it been possible to locate the troops in clean buildings after the victorious force reached Cairo, much of the subsequent sickness would have been avoided. In China, also, at Tinghae, Chusan, the native quarters were found most filthy, and a large amount of preliminary cleansing was necessary before the men could live in them.

In the Kurram Valley I spent the winter and spring camped in the former cantonment of the Ameer at Habib Kila. The village, for it was little else, was found in a most filthy condition. Nevertheless, the gunners of the mountain battery soon had every lane and hut cleaned. Three huts with no ventilation whatever were allotted for the hospital. Large windows were made opposite the doors; the doors themselves enlarged; the walls and floors scraped till clean earth appeared, then leeped and fumigated, and thus a sanitary building obtained. Perhaps one of the most gigantic cleansings was that instituted by General Roberts at Sherpore for the winter housing of the force after the capture of Cabul. The interior of Shere Ali's barracks was filled with many an abomination; but at length most comfortable and clean quarters were obtained. The odours, however, that were perceptible on our first entering the cantonment showed, at any rate, that Shere Ali considered sanitary officers for his force superfluous.

Thus, it will be seen, much can be done in the most unsanitary

villages. Fumigation, scraping, disinfection, ventilation, and leeping will render most habitations habitable. Attention also to the drainage of the immediate locality will then render the ground dry.

Fatigue duties.

Life in Camp.—The relation of fatigue duties to health will be found more especially entered upon under Malaria and Bowel Complaints. Here it may be stated that all such fatigue duties should be conducted in the early morning, and never in the heat of the day. The effect of fatigue duties in the hot sun will be especially shown in the chapter on Bowel Complaints. The excellent huts built of sun-dried "cutcha" bricks by the men of my regiment at Cabul were mostly laboured at in the cool hours of the morning until the hot autumn days had passed into winter. Again, the opposite extreme must not be carried out. Let not the men get idle; one of the reasons why, on the line of communications, cavalry are generally healthier than infantry, is that their stable duties give a constant employment. Relieve the monotony of camp life as much as possible; let the bands play, and institute games and recreation. In the Khost expedition we had our gymphanas, affording sport for both officers and men; again, in the Kurram Valley, during the cholera epidemic, a weekly gymphana was held; at Cabul the same were instituted.

Bathing parades.

Bathing parades must be instituted daily wherever there be opportunity; the early morning hours should be chosen. There is no greater preservative against camp sickness than hardening and cleansing the skin with fresh water.

Night duties.

Night duties should be as limited as possible, conformably to military precautions. The especial points of observation are laid down in the chapters on Bowel Complaints and Malaria. In all cases some rough shelter should be erected. When the vicissitudes of day and night temperature are great, disease is especially liable to arise. Again, Sir Frederick Roberts has drawn attention to the *general* deteriorating effect of sentry duties on the constitution; he explains the quicker onset of effects of age on the private soldier after thirty, by the influence of sentry duties. The non-commissioned officers do not age so quickly, but then they have none of the latter.

Illustrations. Ashanti, 1863.

I now close this chapter with a few illustrations of the points alluded to. In the disastrous Ashanti expedition of 1863 there were two camps—at Swadroo and at Prahsu—which showed a marked difference in disease. The more healthy camp at Swadroo was situated in the forest, it is true, like that of Prahsu, yet the camp itself was on a slight elevation, and a quarter of a mile from the river; the site also was comparatively open; the number of men in camp was much smaller, and the facilities for hutting them superior. At Prahsu the camp was pitched just on the river, was immediately surrounded by enormous trees and jungle, was far more crowded, and the men were not nearly so well housed.

Swadroo.

Prahsu.

Russian campaign against

"During the two summer months that succeeded the departure of the advance guard, the camp at Tchikishlar was like a furnace.

The desert lying between it and the outpost of Chat was not inaptly compared to the parched surface of a baker's oven. No vegetation existed at Tchikishlar, and not a vestige of green for miles around it. Exposed to the tropical heat, the feverish miasma, the tortures of the mosquitoes and flies, the impure water, the nauseous negligence of camps in general and of Russian camps in particular, the troops sickened and died. Epidemic disease of every description raged amongst them" (Marvin). In their letters to their friends, the officers truly described the spot as the "Sierra Leone of the Caspian Sea." With this warning I leave now the subject of camps.

Turcomans, 1879.

CHAPTER VIII.

FOOD.

The question of feeding the soldier in tropical campaigns is one of the most complicated nature, and has to be considered under divers heads. For instance, the food of the British and native soldier must be separately considered. Then, as regards both classes, the food question resolves itself into the questions of the elements of the food for work and heat; the amount of food for any given work; the qualification of food by a hot climate for British soldiers, if any; the variation of the food; the cooking of the food; the questions of alcohol or total abstinence; and the causation of disease by food. The subject is vast, and I can only hope to lay down the general principles guiding these questions.

Relation of the Elements of Food to Work and Heat.—Formerly, as regards the production of force and heat, Liebig's theory was held, that the albuminates of the food supplied the force, and that the non-nitrogenous elements simply served for the production of heat. Lyon Playfair also holds that the transformation of the nitrogenous food in the body is sufficient to account for all the mechanical force of the body without supposing that the fats and starches have any share in it. He held that, inasmuch as, according to his views, *all* the non-nitrogenous constituents of the food were required to account for animal heat, they were merely heat-givers, and could never act vicariously for albuminous bodies as tissue-formers. But more recent physiology has shown that during rest the amount of nitrogen excreted is nearly the same as during work. The view now held generally is thus stated by Fick and Wislicenus:—"A bundle of muscular fibres may be looked upon as a machine consisting of albuminous material, just as a steam-engine is made of metal. Now, as in the steam-engine coal is burnt in order to produce force, so in the muscular machine carbonaceous material is burnt for the same purpose. And in the same manner as the iron of which the engine is constructed is worn away and oxidized, so also is the constructed material of the muscle worn away. In a steam-engine moderately fired and ready for use, the oxidation of muscle would go on tolerably equably, and would not be much increased by the more rapid firing necessary for working, but much more coal would be burnt when it was at heavy work than when the work was only trifling." There is, however, some wear and tear of the engine, and there is also some increase in the expenditure of the albuminous structures of the body; hence, besides an

increase in the non-nitrogenous materials, some increase is also required in the nitrogenous during increased work. For continued work at high pressure must strain the engine, and continued extra work will in like manner strain the muscle. But as regards all forms of energy, they arise from the non-nitrogenous elements. Now, the body has been aptly termed a machine for converting potential into actual energy (Foster). Food supplies the potential energy, which, by the metabolism of the body, "is converted into the actual energy of heat and mechanical labour." The mutual relation of income and expenditure has been calculated to a certain degree of exactitude. Taking Ranke's well-known standard diet (which is better than that of Moleschott, as the latter calculated his diet from prison fares), it is found that it yields about 1,000,000 units of force or metre-kilogrammes. Now, a good day's work equals 150,000 metre-kilogrammes; subtracting this from the total would give 850,000 metre-kilogrammes as expended in heat-production, or, in other words, $\frac{1}{5}$th to $\frac{1}{6}$th of the total income of food is expended as mechanical force and $\frac{4}{5}$ths or $\frac{5}{6}$ths as heat.

We have so far, then, seen that active energy, whether as heat or force, is connected with the non-nitrogenous elements, and that the income of the body is expended $\frac{1}{5}$th for force and $\frac{4}{5}$ths for heat. There is one more preliminary to determine. The nitrogenous elements likewise demand a certain amount of increase with increased work, as I have stated. On account of the greater tension of the machine, the machine as it wears must be strengthened, and therefore, if an increased amount of nitrogen be not supplied by the food, the active muscles will subtract it from parts less actively employed, as the heart, or will feed upon themselves. Thus, with increased work, whilst increased fuel is required, at the same time the "Spannkraft" of the machine must be strengthened.

Amount of Food for Campaigns.—We have now to consider the calculation of the amount of food to be supplied. We must first calculate the amount of work to be performed, and afterwards consider the modifying influence, if any, of a hot climate. For, as observed by Karl Semper, the amount of nourishment required within a given time stands in the closest relation to the functional activity of the individual organs, to the size of the animal, and to its special adaptation to a certain mode of life. Now, according to circumstances, the amount of nourishment required must differ widely, even in individuals of the same species. But between the dangerous extremes of actual over-eating and starvation there is a graduated scale approaching a point which is to be regarded as the most favourable for the individual. This amount of food Semper designates as the *optimum*. What, there- Optimum. fore, we, as medical officers of the army, have to determine, is the "optimum" for soldiers campaigning in hot climates; for every deviation from that "optimum" must be more or less injurious to the individual.

First, then, as regards the amount of work to be provided for. Amount of work.

It is laid down that a fair day's work for an average man is about 300 foot-tons per diem, whilst a hard day's work equals 450 foot-tons. Now, a march of ten miles in heavy marching order is equal to 250 foot-tons. But, as Dr. Du Chaumont remarks, troops in the field do more work than is represented by the mere marching. There are fatigue duties after coming into camp; there is more bodily and mental waste of tissue; and generally the quality of the food is not good. Hence he holds that a war diet should provide for a minimum work of 350 to 400 foot-tons, and be capable of being increased at the shortest notice to 500 foot-tons. Such a desideratum would be fulfilled by a diet of nitrogen, 350 grains; carbon, 5500 grains; salts, 450 grains (equal in potential energy to 4280 foot-tons). And the increased work would require a diet containing 450 grains nitrogen, 6500 grains carbon, and 500 grains salts.

Preparatory diet at peace.

Before the soldier has embarked on a campaign in the tropics he has been, however, under-fed. Both Parkes and Du Chaumont have shown this. A fair day's work equals 300 foot-tons, and, putting the soldier's work at home as at this amount, he does not get a diet sufficient for this work. Taking the mean of Pettenkofer and Voit standard diets, Prof. Du Chaumont shows that they contain 324 grains nitrogen, 4921 grains carbon, and 463 grains salts, whilst the soldier's diet at home gives only 257 grains nitrogen, 4725 grains carbon, and 358 grains salts; or comparing them we find—(1) In standard diet for average day's work: Nitrogen, 324 grains; carbon, 4921 grains; salts, 463 grains. (2) In soldier's diet in peace: Nitrogen, 257 grains; carbon, 4725 grains; salts, 358 grains. Thus, presuming the soldier's work in peace to be an average day's work, we actually in theory do not give him enough fuel for his work, nor reparative material for the machine, nor salts enough for his framework, nervous energy, or digestive powers. And in this state we send him forth to campaign in a hot climate. If, as is undoubtedly true, insufficient food predisposes to all diseases, especially epidemic diseases, it is at once seen how deleterious this insufficient diet must be.

Requisite diet in peace.

Dr. Du Chaumont has indicated to all concerned how to supply the deficiency by adding at least $\frac{1}{5}$th the amount of nitrogen in the way of meat, cheese, or legumes; by doubling the fat by means of fat bacon, butter, or oil; by slightly increasing the salts by the above additions. The soldier should have 4 oz. of meat added to his existing ration of 12 oz. (of which, be it noted, $\frac{1}{5}$th is already bone).

Requisite diet in war.

Thus far, then, we see that in the matter of prevention of disease in hot climates arising from those two chief factors, fatigue and incomplete nourishment, it is necessary to increase, in the first place, our men's diets in time of peace, so that they should not embark on the campaign with frames insufficiently nourished. Having, then, embarked on the campaign, they will need a diet producing at a minimum 350 to 400 foot-tons of work equal in potential energy for supplying 4280 foot-tons. The remaining

question, then, is concerning any modification of this diet in relation to the *tropical* element. In tropical war?

To determine the question, then, whether hitherto the soldier has obtained a proper diet in campaigns, and to determine if any modifications are necessary in quantity or quality in a tropical campaign, let us review the war diets that have been granted, and the opinions of authorities on the subject. The following, then, have been some of the rations for British troops:—

In the China war the men were granted—Fresh meat, 1½ lb.; biscuit, 1 lb.; vegetables; occasionally bread; tea; sugar; ½ gill rum. China, 1860.

In the New Zealand war—Bread, 1½ lb., or biscuit, 1 lb.; fresh meat, 1 lb., or salt meat, 1 lb.; 1 gill (¼ pint) rum; 1 lb. fresh potatoes, or 4 oz. preserved potatoes, or 4 oz. rice, or 1 oz. compressed mixed vegetables, or ⅓ pint peas. But potatoes were always given when obtainable. A grocery ration in addition, to be presently alluded to, of sugar, 2 oz.; coffee, ⅓ oz.; pepper, $\frac{1}{36}$ oz.; tea, ⅙ oz.; salt, ½ oz. New Zealand, 1863–5.

In Abyssinia, as far as Antalo, from where the great advance was made, the ration was the same as in India, with the exception of a daily addition of 2 oz. compressed vegetables and an increase of meat up to 1½ lb. *Beyond Antola* the ration was—Flour or biscuit, 1 lb.; meat, 1½ lb.; sugar, 1½ oz.; ghee, 2 oz.; tea, ½ oz.; compressed vegetables, 2 oz.; rum, 1 dram; besides condiments, salt, ¾ oz. Abyssinia, 1867–8.

In Looshai—Biscuit, 1 lb.; sugar, 2½ oz.; flour, 6 oz.; butter, 1 oz.; meat, 1 lb.; vegetables, 8 oz.; rice, ¼ lb.; tea or coffee, $\frac{5}{7}$ oz.; salt, 1 oz. Each officer, rum, 2 drams; pepper, 2 oz.; vinegar, 2 pints. Looshai, 1871–2.

In Ashanti.—Here there was a great improvement as regards variety—*Bread*, 1½ lb., or 1¼ lb. biscuit, or 1 lb. flour; *meat*, 1½ lb. fresh beef, or 1½ lb. salt pork, or 1½ lb. salt beef, or 1 lb. preserved mutton (¾ lb. of sausage might, in special cases, be substituted for half the ration of salt or fresh meat, or for ¼ lb. preserved meat); *vegetables*, 2 oz. rice, or 2 oz. peas, or 4 oz. preserved vegetables, or 4 oz. preserved potatoes, or 1 lb. fresh potatoes; *groceries*, ¾ oz. tea, 3 oz. sugar, ½ oz. salt, $\frac{1}{36}$ oz. pepper; *tobacco*, 1 lb. per month per man; *cheese*, 4 oz., might be substituted for one-third ration of meat. There were also some portable foods. Ashanti, 1873.

The ration in Afghanistan was—Fresh meat, *exclusive of bone*, 1 lb.; bread, 1¼ lb., or biscuit, 1 lb.; rice or flour, 4 oz.; sugar, 3 oz.; tea, ¾ oz.; salt, ⅔ oz.; potatoes, 10 oz.; green vegetables when procurable, 6 oz. (if green vegetables not procurable, then dhall, 1 oz., and potatoes, 12 oz., were given); *rum*, 1 dram per man authorized—one-half at dinner, the remainder in the evening after sunset (an extra rum ration to the above could be issued in cases of unusual exposure or exertion or fatigue); *tobacco*, ½–¾ lb. per month. During General Roberts' march to Candahar, the meat ration was increased to 1½ lb., and ½ tin of Kopf given to each European daily. Afghanistan, 1878–80.

Zulu, 1879. In the medical history of the Zulu war, it is simply stated that "the usual field ration" was given. I am therefore unable to give the details, as there is no "usual" field ration laid down.

Egypt, 1882. For the operations of war in Egypt in 1882 a special field ration (A) was advised, but apparently not given, the ration B being issued.

A.		B.	
Meat . . .	1 lb. 4 oz.	Meat . . .	1 lb. 0 oz.
Bread . .	1 lb. 0 oz.	Bread . .	1 lb. 4 oz.
Potatoes (fresh) .	8 oz.	Fresh vegetables .	8 oz.
Tea	$\frac{1}{2}$ oz.	Tea	$\frac{1}{6}$ oz.
Lime-juice . .	$\frac{1}{2}$ oz.	Coffee . . .	$\frac{1}{3}$ oz.
Sugar . . .	$\frac{1}{4}$ oz.	Sugar . . .	2 oz.
		Salt	$\frac{1}{2}$ oz.
		Pepper . . .	$\frac{1}{36}$ oz.

But for the first four days after landing the men only had preserved meat, biscuits, and groceries.

C. After September 20 a modified ration was issued—

Meat, 1 lb.	Potatoes, 8 oz.	Sugar, $2\frac{1}{4}$ oz.
Bread, 12 oz.	Vegetables, 4 oz.	Lime-juice, $\frac{1}{2}$ oz.
Erbswurst, 1 tin	Tea, $\frac{1}{6}$ oz.	Salt, $\frac{1}{2}$ oz.
Rice, 4 oz.	Coffee, $\frac{1}{3}$ oz.	Pepper, $\frac{1}{36}$ oz.

When Erbswurst was not issued with this, the meat ration to be 1 lb. 4 oz. Finally, after active operations had ceased, the ration (D) was as follows:—

Fresh meat, 1 lb.	Vegetables, 4 oz.	Tea, $\frac{1}{3}$ oz.
Bread, 1 lb.	Salt, $\frac{1}{2}$ oz.	Coffee, $\frac{1}{3}$ oz.
Rice, 2 oz.	Pepper, $\frac{1}{36}$ oz.	Sugar, $2\frac{1}{4}$ oz.
Potatoes, 12 oz.		

Suakim expedition, 1885. In the Suakim expedition of 1885 the ration for the troops was as follows:—Bread, $1\frac{1}{4}$ lb., or biscuit, 1 lb.; fresh meat, $1\frac{1}{4}$ lb., or preserved meat, 1 lb.; tea, $\frac{1}{3}$ oz.; coffee, $\frac{1}{3}$ oz.; sugar, $2\frac{1}{4}$ oz.; salt, $\frac{1}{2}$ oz.; pepper, $\frac{1}{36}$ oz.; potatoes or fresh vegetables, 12 oz.; compressed vegetables, 1 oz.; occasionally, jam or marmalade, Erbswurst, 2 oz., and lime-juice, $\frac{1}{2}$ oz.; sugar, $\frac{1}{4}$ oz., and rum, $\frac{1}{16}$ oz., together, when ordered. Lime-juice ordered to be given invariably when potatoes or fresh vegetables were not supplied.

Let us now see how these diets come up to the requisite war ration, which, at starting, Dr. Du Chaumont considers should contain—nitrogen, 350 to 400 grains; carbon, 5500 grains; salts, 450 grains. Calculating the amounts of nitrogen, carbon, and salts from the data on p. 202 of the sixth edition of Parkes' *Hygiene*, the war rations of Abyssinia, Afghanistan, Egypt, and Suakim (1885) were as follow:—When flour was served out, and

Abyssinia, 1867-8. taking compressed vegetables as dried peas, the diet in Abyssinia beyond Antalo contained—

	(1).		And (2) with Biscuit.
Nitrogen . . .	400.8 grains	...	452.0 grains
Carbon . . .	4299.0 ,,	...	4523.0 ,,
Salts . . .	325.0 ,,	...	325.0 ,,

Therefore, this diet contained the proper proportion of nitrogen,

but was greatly deficient in carbon and salts. All agree that the ratio of N to C should be as 1 : 15; here it was but as 1 : 10; whilst the salts were one-quarter less than they ought to have been.

In the diet in Afghanistan I have allowed solely for bread, and I have calculated for dhall and potatoes *vice* fresh green vegetables and potatoes, as I never saw green vegetables during the campaign. Afghanistan, 1878–80.

The following, then, are the results :—

	On Rice Days.		On Flour Days.
Nitrogen . . .	428.24 grains	...	444.24 grains
Carbon . . .	5298.00 ,,	...	5296.00 ,,
Salts . . .	346.00 ,,	...	368.00 ,,

This diet, then, shows a better proportion between the N and C of 1 : 12; the amounts of carbon are higher, but still not as much as they ought to be. But in General Roberts' march the meat ration was increased 8 oz. It may be mentioned that in the above ration for Afghanistan the meat has been calculated as meat of the *best* quality, without bone, for certainly the mutton supplied in Kurram was as good as possible. The fat mountain Afghan sheep are unrivalled. In General Roberts' march to Candahar the following was yielded :— General Roberts' march, 1880.

	On *Flour* Days.		On *Rice* Days.
Nitrogen . . .	557.36 grains	...	540.96 grains
Carbon . . .	5702.00 ,,	...	5348.00 ,,
Salts . . .	422.00 ,,	...	402.00 ,,

Considering the wear and tear of the machine, I think the proportion of nitrogen correct, but the amount of carbon for fuel too small. And this, indeed, was borne out by facts, for, as I have shown, the only factor that distressed the men and officers was the *fatigue*.

In Egypt we have seen that, instead of the proposed ration, another ration was given. Now, both rations were deficient as a war ration, but the one actually given far the most. Egypt, 1882.

	Proposed Ration.		Ration *given*.
Nitrogen . . .	306.20 grains	...	286.80 grains
Carbon . . .	4128.00 ,,	...	3996.00 ,,
Salts . . .	260.00 ,,	...	248.00 ,,

This ration shows a lamentable falling off from the liberal ration of the Afghan war. Luckily, the campaign was a comparative walk over; yet how would the men have fared on such a ration in a march like that of General Roberts?

In Suakim, calculating only for fresh meat and fresh vegetables, with bread or biscuit, we get the following results :— Suakim, 1885.

	With *Bread*.		With *Biscuit*.
Nitrogen . . .	347.80 grains	...	410.80 grains
Carbon . . .	4460.50 ,,	...	4020.50 ,,
Salts . . .	292.00 ,,	...	304.00 ,,

The nitrogen is sufficient, but the carbon and salts are again deficient.

So far, then, no perfect diet has been given to the campaigning soldier. The most satisfactory diet has been that in the Afghan war, but here also there was a deficiency in carbon, whilst salts, if the bulk ration of salt is included, were slightly too much. More carbon certainly is necessary. Now the proportion of N to C in *cheese* is nearly as 1 : 7, in oatmeal as 1 : 21. Both are capital articles to work on, and both keep well in tins in hot climates. Some re-adjustment of the diet might accordingly be made by employing these articles. Bacon, in which N : C :: 1 : 24, would be excellent for portions of the diet.

Climatic Qualification.—According to the environment a definite relation must exist between the amount and kind of food to obtain the "optimum" of food. Albuminates, hydrocarbons, carbohydrates, and salts must exist in certain proportions for the attainment of the best result. Now, we have seen that the income of food results in an outcome of bodily movement and body heat. The body must produce more heat in cold climates, and hence the inhabitants of cold climates must eat more starches and fats on account of the carbon contained. The appetite for fats is also greater in cold climates. Now, does the reverse obtain in hot climates, and, if so, must a corresponding modification be made for campaigns in hot climates?

We have already seen that about $\frac{1}{5}$–$\frac{1}{6}$ of the income is expended as mechanical force, and about $\frac{4}{5}$–$\frac{5}{6}$ as heat. Kering and Funke have determined that with increase of external heat less body production of heat takes place. Hence, inasmuch as less heat is required to be produced in a hot climate, so less heat-producing material need be ingested. But in a campaign the question is not so simple. Let us look at the general question first before applying it to campaigns.

Carpenter. Dr. Carpenter on this question puts it thus: Every change in the condition of the organic components of the body, in which their elements enter into new combinations with oxygen, must be a source of development of heat: and as a considerable portion of the CO_2 and H_2O exhaled in respiration is formed within the body by the metamorphosis of its own tissues, and since this metamorphosis is promoted by the active exercise of the nervo-muscular apparatus, it follows that in animals whose habits are peculiarly active, living in climates in which the surrounding temperature is high enough to prevent any cooling influence, the combustive process thus maintained may be adequate for the maintenance of the temperature of the body at its own normal standard.

Hence, here it would appear that we do not want to provide for the heat of the body in the tropics, but only for the work done *where there is a peculiarly active life.*

Carpenter next says that the general experience of inhabitants of warm climates is in favour of a diet chiefly or entirely vegetable, inasmuch as such a diet affords an adequate supply of the albu-

minates, in combination with the other classes of foods, without affording more fuel than the system requires. The derivation of the constituents of the food from the animal or vegetable kingdom is not a matter of indifference, for a highly animalized diet tends to raise the proportion of red blood-corpuscles in the blood, whilst a corresponding vegetable diet has a tendency to lower them.

The more nearly the diet is assimilated to that of the natives of the East, in the substitution of fruits and farinaceous substances for oleaginous articles, the less will be the liability to disordered digestion. Prof. Maclean used to warn his class never to eat meat more than once a day. A large proportion of the digestive mortality in the tropics results from the habitual ingestion of a larger quantity of food, and that of a rich, stimulating character, than the system requires; hence follows loss of appetite, not due to the climate, but to repletion. Maclean.

As regards fat, also, the Hindoo takes ghee in plenty, so that a certain amount is necessary, but there is not that craving for fat that is found in cold climates.

So far, then, we have gathered—

i. That by very active work in hot climates the necessary temperature of the body may be maintained by such active work.

ii. That a vegetable diet is preferable to an animal in not affording any surplus of combustive material in hot climates.

iii. That an animal diet is preferable to a vegetable, in raising the proportion of red blood-corpuscles (which proportion, as we have seen, in hot climates is lowered).

iv. That a certain proportion of fat is necessary, after all, in hot climates, but that its proportion is to be less than in cold climates.

The main consideration, so far, has been with regard to the heat-producing elements. Let us now consider the question of vegetable *versus* animal diet more closely.

There seems to be a great consonance of opinion for the reduction of animal food. Dr. Crawford holds that in the tropics the meat should be reduced and vegetables increased. Dr. Roth that the diet should be likewise altered in accordance with the diminished desire for meat and increased desire for vegetables. Mr. Stanley, the African explorer, warns against gratifying "the seemingly uncontrollable and ever-famished lust for animal food." And assuredly where there is this "lust"—when young soldiers fresh in India devour great junks of meat with extraordinary appetite—there is need for warning; for too animal a diet will produce fevers and digestive disorders and predispose to sunstroke. In the hot weather in India in the plains, the work of the soldier is very small. Dr. Inglis, however, in regard to the fact that the meat supplied in India is very inferior, holds that a ration containing 1 lb. of meat does not over-feed the soldier. So much, then, regarding the conflicting views concerning animal food. On the side of vegetable food it has been urged—(1) that there is far

Crawford. Roth. Stanley. Inglis.

less liability to the production of congestion of the abdominal viscera, and that, therefore, such food is especially indicated in warm countries; (2) that a larger relative proportion of starches is contained by vegetable food, and that a larger relative proportion of starches should be taken in hot climates; and (3) that the tendency to scurvy in hot climates is thereby obviated. It would therefore appear that the food in the tropics for soldiers generally should contain a larger proportion of fresh vegetables and less animal food, having regard to the diminished work performed in the hot weather.

But with the onset of a campaign the situation is at once changed, for here the factor, not only of work, but also of excessive work, comes in. Is, then, the regimen of peace in hot climates to be followed out in war in hot climates? It is a difficult question to answer. Speaking personally, a diminished desire for animal food and fat in the hot weather is experienced; but as regards the Afghan campaign, when *marching*, no such desires were present. On the contrary, the appetite for meat and butter was as healthy as in England. But, again, when simply resting in camp on the line of communications a vegetable preponderance in the food was preferred. Hence it would appear that during the active hardships of a campaign the diet as hitherto proposed as a sample is applicable for hot climates. The extra meat ration given out in General Roberts' march was fully enjoyed, nor did it lead to hepatic disorders.

Summary. In the *resting stage* of a tropical campaign, let animal food be in part substituted by vegetable. Let the fats be diminished, the carbonaceous elements being furnished rather by the starches. In the *marching and fighting stages*, on the contrary, let the animal food resume its wonted proportions.

One thing is important. At the commencement of a campaign let the ration be ample; a superabundance is better than a deficiency. Such a want of foresight as having to feed the men for the first four days on preserved rations, as took place in the Egyptian operations of war of 1882, is fraught with danger. But of equal, if not greater, importance with the choice of vegetable or animal food are three other factors in hot climates. These are the question of *drink*, *variation of food*, and *cooking*. The relations of fluids will be discussed presently. But at the outset we believe that the better regulation of these three factors is the desideratum most required.

Variation of Food.—Nothing exercises so deleterious an effect on digestion as a monotonous diet. Loss of appetite is bound to arise. Mr. Stanley's observations on the best diet for soldiers during the Nile expedition are specially valuable as coming from an explorer in tropical lands. He insists that soldiers on tropical service need a frequent change of diet to keep them in good health. The horrible monotony of butcher's meat in India doubtless has much to do with the so-called "climatic" diseases. For instance, during the four weeks the force in Abyssinia were south of the Takazie river, the diet was restricted to beef and flour, with

no vegetables. Bowel complaints immediately began to increase. And yet we read that mutton was procurable, but not bought, as the people of the country were unwilling to sell their sheep! Surely, in such a case, the mutton should have been requisitioned.

As regards varying the diet, much may be done by the different preserved meats and vegetables now in the market. In the Afghan war more was done in this way than in any other, and valuable results were obtained. Lastly, advantage should always be taken of the resources of the country.

The diet in war has been varied in some campaigns much more than in others. It may be well to collect the experience gained of the use of the various concentrated and preserved foods. Kopf's consolidated soups were used in the Afghan war. The tins were first analysed at Bombay, with the following results:—Kopf's Erbswurst was found to be by far the best, 1 tin containing nutriment equal to $2\frac{1}{2}$ oz. of meat, $\frac{1}{4}$ oz. fat, and $1\frac{1}{4}$ oz. rice added together; next came Kopf's mulligatawny, the nutritious value being about one-half that of the Erbswurst. Both of these showed good preservation. Kopf's Scotch broth was the least satisfactory, containing only about one-third the nutritious value of the Erbswurst, and not "keeping" so well. Besides Kopf's food, Whitehead's army food was used, but not so favourably reported on. Whitehead's variegated soups were much liked. The most satisfactory of all was certainly the Erbswurst, for it was easily prepared; still, none of these foods should be used *per se*, but in combination with the usual meat ration, so as to vary it or to supplement it. Thus, when it is impracticable to supply a full meat ration, a packet of portable soup may be issued as a substitute for half a ration of meat. Such soups are also especially valuable where great exertion is called for; in General Roberts' march, each soldier had half a tin of Erbswurst before starting. (There is one drawback to the use of Erbswurst coming from Germany, and that is the possible danger of trichinosis.) These foods were also found valuable for the line of march, to be taken half way.

In Egypt 1 tin of Erbswurst was sometimes substituted for $\frac{1}{4}$ lb. of meat; or $\frac{3}{4}$ lb. of sausage for half a ration of salt and fresh meat or a quarter ration of preserved meat.

In Ashanti a cylinder was fashioned to carry in 4 compartments Whitehead's army food, Whitehead's soup cakes, cheese, and condiments, which, with biscuit, gave a portable and varied food for a time.

In Afghanistan salt pork was issued, but discontinued on account of the men disliking it. Australian meat was, however, well liked, and made an excellent dish with vegetables. Chicago beef was found most palatable at the siege of Lydenburg, in South Africa. Salt meats should never be issued more than twice a week, and then only with pickles, vegetables, and lime-juice.

"Carne pura," made from the dried meat charqui, has not, apparently, been yet tried, but would appear to be capable of forming a good soup with vegetables. It is, moreover, quite

palatable. In the Red River expedition pemmican was found very portable, and far more palatable than pork.

We thus see that it is possible to vary in their totality the men's rations by alternating beef and mutton, Australian beef, New Zealand mutton, &c., whilst for part of the whole ration some of the various army foods can be substituted. But the tinned provisions should be of good quality. This was not so in the operations of war in Egypt in 1882. They were reported on as being of very inferior quality, and in some cases even as putrid.

Turning now to the vegetable ration. Preserved and compressed vegetables have been much used. Preserved vegetables are far superior to compressed. Indeed, I much doubt if compressed vegetables should ever be issued. They are tasteless and stringy, and moreover are apt to give rise to diarrhœa by their irritating mechanical properties. Morache, moreover, holds that, under the enormous compression to which they have been subjected, they have lost all their properties, their albumen and salts have departed, and there remains only the cellulose frame-work. Nevertheless, a circular, dated August 23, 1885, was sent round to the medical officers in India, to the effect that the Director of Supplies, War Office, considers that compressed vegetables "have been found suitable for service in the field, and keep well." Concerning their "keeping" properties, I quite agree with the Director of Supplies, for no soldier has any desire to take them away, such is the distaste they soon inspire. Regarding their suitability for service in the field, however, I agree rather with Morache "that they are absolutely of no alimentary value." Yet the Director of Supplies held that 1 oz. of uncooked compressed potatoes equals $\frac{1}{2}$ lb. of fresh potatoes; whilst the Director of the Victualling Department at the Admiralty held that 1 lb. of compressed vegetables equals $5\frac{1}{2}$ lb. of fresh. It is evident that these officials have never campaigned on compressed vegetables. Preserved vegetables, on the other hand, have not the above objections; their salts and other constituents remain. 2 oz. of uncooked preserved potatoes are held at the War Office to equal 8 lb. of fresh, or 1 lb. of preserved to equal $3\frac{1}{4}$ lb. fresh potatoes at the Admiralty. Whenever such vegetables are used, they should be well soaked in water previous to use; otherwise, irritation of the bowels will ensue. As regards peas and beans (split), they should never be used when fresh vegetables of any sort can be obtained. With both preserved vegetables and dried legumes always give lime-juice.

Summary. I may now sum up a few of the results to be attained in campaigns in warm climates, where especially we have to guard against monotony of diet:—

1. Vary the food by the different tinned meats from Australia, New Zealand, and America, but beware of *cheap* and inferior supplies.

2. Where possible, drive live cattle with the force in preference to carrying meat supplies.

3. Discard all compressed vegetables, using, where necessary, only preserved.

4. Requisition the invaded country for supplies.

5. Look out for the natural products of the country. Yams were obtained in Malay; melons, potatoes, and cucumbers in Afghanistan; wild cress, cabbage, and sow thistle in New Zealand; begonia and elephant apple in Aka. Fowls can be obtained also everywhere generally.

6. Never give salted and preserved rations at a stretch. In Looshai at first the European officers only got salted and preserved rations, and their health became seriously affected, whilst the preserved rations caused much palling of the appetite. As soon, however, as fresh provisions were brought up, the digestive disorders rapidly amended. The natural resources of Looshai were very poor, and sheep had accordingly to be continually sent up to the troops. This campaign, Dr. Buckle emphatically stated, showed that the general health could not be maintained in the absence of fresh meat. Again, for men undergoing great exertion, never give only tinned meat for more than one day.

There are yet a few other points: Biscuit, as regards nitrogen, is superior to bread, but the men soon get tired of continuous biscuit. Let the bread be well baked, the more crust it contains the more nitrogen also. Good brown bread would be preferable to white, as it keeps the bowels regular, and, moreover, has cleansing properties. Where greater exertion is required, the bread ration is to be increased equally with the meat. Finally, let the hours of food be as regular as possible, and, above all, let the men have something substantial at their last meal, which should be in the evening and not the afternoon, for it is at night that the body needs most protection against camp diseases.

Cooking.—We now come to consider briefly the question of cooking the food. This is of the utmost importance in the field. Nothing so disgusts the appetite in hot countries as a sodden, ill-looking lump of meat. The school of cooking established at Aldershot should prove an invaluable boon to the soldier. Fortunately, this subject is being more and more recognized by the authorities. Now, the most recent* cooking utensils ordered for the 1st Army Corps during the crisis of 1885 have been shown to be subject to great drawbacks. There is no frypan; there is no flange round the rims of the boilers, and so the food is liable to become soaked. The boiler has an oblong shape; hence, the food in the corners cannot be properly stirred up by the cook, and is served up in a half-cooked state. This shape also renders their cleansing less easy, and they are liable to remain dirty in parts. This shape, again, causes increased difficulty in tinning the copper of which they are composed. The covers are supposed to act as frypans, but there are many drawbacks to this plan. In 1875 such cooking vessels (only square) were rejected after trial on account of the food always being smoky, and now they are re-introduced. Now, I hold all cooking vessels should be round, and also be made of block tin. In the absence of opportunities for "tinning," diarrhœa

* Colonel Hawke's plan.

and abdominal cramps are set up, and, once started, will of course predispose to severe "bowel complaints" or cholera. In the Kurram Valley, the officers of the battery with which I at first served suffered thus. All the large cooking boilers, then, should be of block tin, round in shape, and with frying-pans. Block tin, of course, is more expensive, but everything that conduces to a better state of health must be cheaper in the end. A further disadvantage of tinning cooking vessels is the adulteration of lead that may occur in the tinning material. Brigade-Surgeon Boulton has drawn attention to this. To test tinning material for lead a simple process has been laid down. A mark is to be made on unglazed paper with the material; this is next moistened with glacial acetic acid, and then allowed to dry spontaneously. On wetting it with iodide-of-potassium solution, if yellow coloration appears, lead is present.

Smaller cooking utensils also should be provided, so that the soldier may have some food always ready. Nothing can equal Warren's cooking pots for this purpose; by these soup and meat can be cooked with pudding and vegetables at the same time, and stews also of the most strengthening kind. On the line of march for breakfast nothing can be better. The Austrian field iron digester is also good for forced marches where there is not time to cook the meat before starting; carried with the baggage, by the time the march is over the food will be found cooked. The Norwegian automatic cooking vessels serve a similar purpose. In the Nile expedition, in camp before the force arrived at Assouan, Flanders' kettles were used, and Soyer's apparatus. Afterwards, field ovens were built. Besides these expedients, I think the Russian "samovar" could, with great advantage, be introduced into our services. Nothing would better conduce to warding off the effects of fatigue. Tea after the end of a long march in the heat is perhaps the most refreshing of beverages. Eggs can be boiled in it, and bread toasted. Dr. O'Heyfelder gives a cheery picture of the soldiers sitting round, talking and singing, the fatigues of the previous march apparently quite forgotten.*

Causation of Disease by Food.—Finally, with respect to food, care must be taken that it be not a source of disease. In the analytical part of this work it will appear that, in the prevention of the several diseases incidental to hot campaigns, a full and sufficient diet is necessary. Again, it will be seen how diseased food can more especially give rise to bowel complaints, and perhaps to typhoid fever; how food poisoned with cholera and typhoid can cause cholera and typhoid; how food, also, can intro-

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* Since the above disquisition on cooking was penned, orders by H.E. the Commander-in-Chief in India have been promulgated for the promotion of better cooking for the British soldier. Sir Frederick Roberts has directed that classes for instruction in cooking be instituted. Classes at which a certain number of men from each troop, battery, or company in India are to be taught to prepare and cook food are to be held. The men are to be instructed and exercised in cantonments, on the march, and in manœuvres. Prizes are to be given, and useful hints as to the division and methods of cooking are promulgated.

duce parasites into the system, and how an insufficiently proportioned food can cause scurvy. It is thus seen that food can spread disease: (1) by being itself in a diseased condition; (2) by serving as a culture-medium for specific germs; and (3) by serving as a place of selection for living parasites; and (4) by being in such proportions as regards the four classes of constituents, as to be insufficient for health. The great rules in the field are: (1) to thoroughly cook all meat, and boil all fluids, such as milk or water, served out to the men; and (2) to reject all food supplies wherever there is a doubt of their being fresh. That this has not always been done will be shewn in the chapter on Bowel Complaints.

Fluids.—Alcohol must now be discussed. The evidence adduced against the rum ration by the late Prof. Parkes we now compare briefly with further experience. The evidence of Parkes brings us down to the Ashanti war. Alcohol.

When the Sunjhie-ujong expedition started from Singapore, it was determined that tea, coffee, and chocolate were to take the place of any spirit ration. The men from Malacca took, therefore, no spirits. Off Lookut, however, a naval brigade was formed, and, on representation, the authorities decided that the bluejackets should have their usual grog ration. The medical report states "that it was a pity that the original intention was not followed out. The Malacca men performed very hard work without spirits, and the others could have done the same." The rum ration was always served out after the day's work. In the Malay force one pint of porter and one dram of rum were issued alternately, but not till the day's work was over. The rum was to be well diluted. Half an hour before the rum issue a ration of quinine was given. The sickness in relation to the rum ration in this campaign influenced the medical report to state that a temperate one of alcohol was better than total abstinence. The results were as follow:— Sunjhie-ujong, 1874-5.

Total abstainers	*Admission* for fevers	142.85	per 1000
Temperate	" " "	30.61	"
Total abstainers	" " other diseases	47.61	"
Temperate	" " "	37.07	"
Total abstainers	" " bowel complaints	285.71	"
Temperate	" " "	122.44	"
Total abstainers	*Mortality* " "	95.23	"
Temperate	" " "	17.00	"
Total abstainers	Mortality of total admission	95.23	"
Temperate	" " "	30.60	"

Here, certainly, the total abstainers had the worst of it. But the medical report further states, "that the men of the most intemperate habits" had the *lowest mortality;* so that if one argues that temperance is better than total abstinence, from this expedition, one ought also to argue that intemperance is better than temperance, which is absurd. The only question that can be raised is whether in damp, rank jungles alcohol is of value, and here the evidence is most contradictory.

Jowaki, 1877–8. In the Jowaki campaign a rum ration was given; a second dram also on payment was allowed when bivouacking in torrents of rain. The rum ration was considered beneficial, and a much better ration "for a man below par and drenched to the skin than tea or beer."

Galeaka-Gaika, 1877–8. In the Galeaka-Gaika campaign, in South Africa, rum was only issued on the order of the medical officers. A special remark is found concerning it, that the good health enjoyed was due to this enforced abstinence.

Afghanistan, 1878–80. In the Afghan war one dram was authorized, half at dinner, and half in the evening after sunset. An extra ration could be used after unusual fatigue or exertion. In General Roberts' march this extra issue was only found necessary *three* times. On one of these occasions the non-drinkers received in its place an extra meat ration.

Zulu, 1879. In the Zulu war, rum was only issued on the recommendation of the principal medical officer, when 2 oz. per man were allowed. But in the first division it was issued more frequently—twice a week—by the order of the general. It had here, however, no preventive effect.

Natal and Transvaal, 1880. In the operations in Natal and Transvaal, rum was only issued occasionally: when, during the various sieges, the duty had been severe, and the weather very inclement. The medical officers all spoke highly of its issue under these circumstances.

Egypt, 1882. In the operations of war in Egypt in 1882, no rum was issued, but only red wines as stimulants. The only exception to this general rule was the issue of a spirit ration three or four times in the evening when the work had been very hard. The absence of rum was held to be the chief cause of the few cases of sunstroke.

Aka, 1884. In the Aka expedition, once a week, the men received a dram of rum, and on occasions when the work was very hard they received an extra ration (only native soldiers were employed here).

E. Soudan, 1884. In the Soudan, in 1884, rum was only issued when authorized by a medical officer, and given with lime-juice and sugar.

Suakim, 1885. No alcohol was issued with the rations in the Suakim expedition of 1885, and the non-issue "largely contributed to the efficiency of the troops during their arduous duties." Bechuanaland. In Bechuanaland, also, alcoholic drinks were forbidden, and there was an absence of cases of sunstroke, whilst Deputy-Surgeon-General Faught expressed his conviction that the excellent general health of the troops was "mainly due to the impossibility of obtaining intoxicating drink." Besides the above experience, we have that of the French army in Algeria, with whom hepatitis is a rare Algerian army. complaint. The French army does not have a spirit ration; when alcohol is taken it is in the form of *vin ordinaire*. It is issued after hard fighting or fatiguing marches. Again, going further back in our history, when circumstances induced abstinence, we Egypt, 1802. find that it is stated, concerning the Egyptian war of 1802, that only light Greek wines were taken, and that the men were frequently obliged to take only water. "Never before was an army

so abstemious, and consequently so well conducted. The resolution, patience, and spirit with which the soldiers bore the trying climate was greatly due to the fact they were frequently obliged to drink only water."

Finally, at Walcheren, it is related that the German Guard, from their temperance and regular habits, were the most healthy corps of every service. This evidence, though not concerning a tropical climate, is adduced in relation to the question of malaria. Walcheren German Guard.

In the question of allowing alcohol on campaigns, one should not pass into extremes. The daily ration of rum is to be condemned, but so, also, is total abstinence to be avoided. There are occasions in which a ration of alcohol has proved of the greatest service. As tending to the training of a man for a tropical campaign, we quite agree with Dr. Veale in condemning the regulation porter allowance in India. Veale points out that porter in India contains 5 per cent. of alcohol to enable it to keep, and that this amount is far too much, but the regulation gives him in addition a gill of 24 per cent. arrack also. Now a man who has been thus dieted, will most assuredly sooner break down on embarking on a campaign than a teetotaler. Still, this is not an argument for total abstinence; it is simply an argument against habitual alcoholic poisoning. Bryden has well pointed out, with regard to this point, that nothing is more inimical to the acclimatizing process in India than the habitual use of alcohol. Summary.

In our opinion there should be no daily issue of rum; there can be no question concerning this. But with advantage light red wines should be issued twice or thrice a week; these well diluted would be most refreshing in hot climates, and, moreover, would be greatly preservative against bowel complaints and cholera. They were supplied for Egypt, and no harm was found to result from their use. Australian wines are excellent and cheap, and readily obtained in India. It must be, however, especially borne in mind that such rations should be given but sparingly to new arrivals in the tropics, and to "unseasoned" soldiers, abstinence would be the better plan for them. On the question of red wines Mr. Stanley strongly recommends their use, as much as he warns against beer or spirits for an army campaigning in the tropics. Red wines indicated.

On the following occasions of a campaign, alcohol has been found beneficial: where men are jaded and fatigued after a long day's march in the sun; and where renewed exertion is required at the end of a march. In Ashanti it was issued with good effect to the men wet through after marching in the rain. Again, in the Galeaka-Gaika campaign; at the siege of Fort Lydenburg in the Transvaal, and at Wakkerstrom, after unusual exposure; in the Eastern Soudan after a long fatiguing march through a country of morass; and on many other such occasions it has been found of great value. But that the issue of alcohol to the men when wet through is not a necessity, was shown in the Red River expedition. Here after the force had left Thunder Bay, it rained forty-five days out of ninety-four; on many occasions the men were wet through for days, yet the health was ever excellent. Cases where alcohol indicated.

No alcohol was allowed, but the men had instead tea rations. On three occasions of General Roberts' march, when the march had been unusually long, and fatiguing from the absence of sufficient water, the men benefited much by it, and rose for the next march refreshed. In all these cases rum was used. I think the ration would be improved by the issue of red wine, which would be not only recuperating, but also preservative against any chance infection of bowel complaint or cholera which especially attack fatigued individuals at night. If red wines could be carried in sufficient quantity, rum could certainly be abolished with advantage in a campaign. In the issue of alcohol to men, however, there can be no question about one point, and that is, it should never be given either just before a march, or during it.

In conclusion, there are two special occasions on which alcohol has been advocated in hot climates—(1) in malaria, and (2) in zymotic disease. As regards malaria, we have seen how it fared with the non-spirit drinkers at Walcheren. Its issue had no more preservative effect in South Africa. In the Zulu war, by order of the general, a rum ration was issued twice a week to the first division. In the rest of the force, rum was only issued on the recommendation of the principal medical officer. Now the first division was very badly camped on low-lying swampy ground, and bowel complaints and fevers were far more rife than in the second division. But as to the reduction of "malarial" fever, the bi-weekly issue of rum had no effect whatever. The evidence of Dr. White, of the 42nd Assam Light Infantry, however, is very strong in favour of an alcoholic ration in malarious climates like that of Assam. He says, as the result of ten years' experience, that "he has never met with a European official or planter who was a total abstainer, whose health did not break down, and so far permanently that he either had to leave the province, or else take a moderate quantity of stimulants" (Reports Nat. Army Bengal).

Malaria.

Zymotic disease.

In regard again to zymotic disease, it has been said that alcohol, inasmuch as it preserves animal matter, and arrests fermentation, may possibly prevent zymotic disease (Farr). But on the contrary, it would appear that it really increases the tendency to zymotic disease, by preventing the due elimination of the azotized products of disintegration from the system, and so inducing a fermentable condition of the blood (Carpenter). Hence I hold that alcohol in the shape of a rum ration is contra-indicated in all cases where "bowel complaints," "enteric," "cholera," and other zymotic diseases are likely to occur. But alcohol, in the shape of *red* wines, is beneficial, both from the vegetable salts and from the tannin contained in them.

Water.

General survey of methods.

The water-supply is a subject of the first magnitude. Let us first gather the methods practised for obtaining a pure drinking in some of our tropical campaigns. In Abyssinia, in places where there was almost a total absence of water, Norton's tubes and Bertier's chain pumps were used with good effect. In Ashanti the tube well did not answer from getting clogged with sand.

Surgeon-Major Gouldsburg instituted the following process of treatment: (1) Subsidence of impurities by alum six grains to the gallon; (2) Filtration through successive layers of sponge, sand, and charcoal; (3) Boiling; and lastly, the addition of a few drops of permanganate of potash. In Malay, Macnamara's filters (four) were sent up for use, on bowel complaints becoming frequent. Pocket filters, at the rate of 10 per cent. of the European force were also recommended but not sanctioned. In Galeaka-Gaikaland Crease's filters were ordered, but not arriving, Lipscombe's filters were served out for the camps. In Zululand, Crease's filters were found most unserviceable for field service, not standing the rough usage. Lipscombe's filters were apparently found more useful. In Egypt, in 1882, wells were dug alongside of the Fresh-water Canal, so that the water could be in a measure purified by filtration through the sand. Norton's pumps were used; subsidence and filtration, treatment by alum, &c. In the East Soudan, in 1884, the troops were restricted to condensed water for drinking and cooking, as all the water was brackish. There was, in this campaign, marked immunity from bowel complaints. At Suakim, in 1885, the s.s. *Calabria* was fitted out with condensing machinery for converting sea water into drinking water. Such have been some of the methods employed. Let us now therefore go into the question a little more closely.

Influence of soils.

In the first place, the water supply depends much on the nature of the soil on which the camp is placed. We have seen that healthy geological soils have, as rule, healthy water. In Egypt, in 1802, much diarrhœa was caused by drinking water containing sulphate of magnesia. Having selected and tested a water source, keep it carefully guarded from pollution by a guard over it; if such a source be a river, let the drinking water be drawn from the highest spot, and let all bathing and washing be below it. If the water supply be near a native village, examine its relations to the villagers; for instance, at Sunjhie-ujong, at one camp, a well was discarded, as it was found that the natives of the village in which it was, bathed in it, and moreover were affected with tinea. The water can be easily* tested in the field by Condy's fluid, or by nitrate of silver. All water in stagnant pools should be avoided; and in this particular especially warn the men on the line of march rather to rinse their mouths than to swallow such water, when none other is obtainable. Lastly, do not use the water of any river near a battle-field after the battle, for corpses may have been thrown in it, and pieces of such corpses may be detached, and poison the water.

Sentries.

Precaution near native villages.

Tests.

At the base.

Pure water has to be supplied at the base, along the line of communications, or in marching. At the base, if unconnected

* (1) *Condy.*—Add to a tumblerful one or two drops of Condy, which will give a very faint hue. If, after standing for half an hour, the pink colour has turned yellowish, the water is unsafe for drinking. (2) *Nitrate of silver.*—Add some concentrated nitrate of silver and expose it to the sunlight. Compare the rapidity and depth of the darkening with some distilled water similarly treated.

with the sea, some of the before-mentioned filters are to be used. Probably, no filter is superior to the Macnamara. Also a distilling apparatus could be carried thither.

When the base is on the sea-coast, all water should be distilled. This had been done previously to the Egyptian campaigns, but not on so large a scale. Thus, in China, steamers distilled water on board, which was carried up the Peiho river in boats. In Abyssinia, until the troops reached the highlands, drinking water was condensed from sea water, as Norton's pumps did not supply sufficient. But, in our late Egyptian campaigns, the distillation has been carried on to a much larger extent. The s.s. *Calabria*, stationed at Suakim, was capable of condensing 64,000 gallons a day. It had enormous cable tanks, containing 750 tons of water, supplemented by forty-eight 400-gallon tanks, so that a very large quantity of water could be sent on shore in boats at once. It is advisable not to drink too copiously from condensed sea water; in Abyssinia it occasionally was found rather brackish, and then to cause bowel complaints. When thus slightly brackish it is best used as oatmeal water. Condensed water is rather unpalatable, and it is advisable to add about six grains of common salt to the quart, or some lime-juice. Should we ever be operating in the Persian Gulf, it is well to remember that in certain parts, especially near Bahrein, there are fresh-water springs in the sea itself, and fresh water can be obtained by passing hollow tubes down into the spring through the sea water.

In some situations the greatest difficulty is experienced in getting good water. Thus, at Ali Musjid, in the Afghan war, the drinking was supposed to contain chemical elements causing diarrhœa. At Vitakri, also, the water smelt strongly of sulphuretted hydrogen. In the Pishin Valley it was very brackish, and the cause of much diarrhœa. In the Russian camp at Tchikishlar, fresh wells had to be dug every day before the force set out against the Turcomans, as the water, after twenty-four hours, became saline, and also tainted with organic films and insects. Iron pipes were then sent for from Russia, and on arrival the water was found to remain pure, but during the long period before their arrival the men suffered much from bowel complaints.

At the lines of communication and advance.

Along the line of communications, or in the march forward, large filtering apparatuses cannot probably at first be at hand, we must use some such method as Dr. Gouldsburg employed in Ashanti. Alum by itself is an excellent means, in the proportion of six grains to the gallon, for causing subsidence of suspended matter. Professor Parkes' * method, by Condy and alum, is another simple and efficient method. We have already described

* Add Condy drachm by drachm to 4 gallons of water, constantly stirring. When the slightest pink tint is perceptible stop for 5 minutes. If the tint has then disappeared, add 36 drops; again, if necessary, add 30 more, and allow it to stand for 6 hours. Then add to each gallon 6 grains of alum, and, if the water be very soft, a little bicarbonate of soda, and allow it to stand for 18 hours. If it is then not clear, filter it through charcoal.

the method of digging wells along the Fresh-water Canal in Egypt in 1882. The water thus percolating through was collected, purified by alum, and then filtered and boiled. Whatever be the process, filtration and boiling must always conclude it, and the filtration should always precede the boiling; if filtration be resorted too last, a water, previously rendered sterile by boiling, may be re-infected by a foul filter, for filters on campaigns are not always clean.

In the advance to Khartoum the water was taken of course from the Nile, and the sanitary officer wisely ordered that it should be taken from the middle of the stream. At the edges of its banks the Nile had often very little current, and, moreover, was always liable to have been contaminated by the natives. Hence trestles were made projecting into the river, 15 feet by 2 feet, and the water taken from the purer and swifter stream. Again, as regards river water, allusion will be found in the chapter on Cholera to the excellent arrangements instituted by Dr. De Renzy for the voyage up the rivers of Eastern Bengal and Assam. It should be a standing rule, always, where possible, to derive water for drinking from the central portion of rivers.

With a few words on filters I may conclude the remarks on drinking water. I have never come across Carferal filters. Carferal. Now Carferal would appear to be peculiarly fitted for campaigning work. In some comparative experiments with spongy iron and silicated carbon, Carferal was found to be superior. It was superior in its rapidity of action; it yielded nothing to the water that would tend to propagate organisms, as is the case with silicated carbon and loose animal charcoal; and all the substance is filtering material, not spoiling by being stored or even by becoming wet. Surely it is the very material for pocket filters.

An excellent filter was shown at the Inventories Exhibition Maignen's filter. —viz., Maignen's soldier's filter. It consists of two parts, a filter case, and a filter frame of asbestos. The using and cleansing appear to be of the simplest character—a great point with the soldier. Moreover, the charcoal can be easily got at, and is so supplied that it can be frequently renewed. It is supplied in tins, each tin holding 20 charges, so that one tin may be served out each week for every 20 filters in general use; or if each man be given a whole tin it will last him for 20 weeks. This is the perfection of a filter, for, besides its simplicity, there is the rapidity of its action to recommend it. The ordinary pocket charcoal filter is a fraud. A thirsty man must have his emotions well under control if he waits till the water has passed through in sufficient quantity, and then even it is difficult to keep clean.

But with the great advance in our knowledge of the relation of micro-organisms to disease, we need also a filter that will stop these organisms. The "Chamberland filter" is constructed with Chamberland filter. this view. It was invented by Mr. Chamberland, director of M. Pasteur's laboratory. The principle of the filter is to force

the water through porcelain porous enough to allow the passage of the liquid, but barring that of the minutest germs. Pasteur has proved that the filter is thus capable of stopping specific germs. They are cheap, costing only about three francs. For their action they require great water pressure, and the process is slow; but where immediate use of water is not required, I think they would serve admirably for use in camp at the base.

Frankland's experiments. Finally, Prof. Frankland has recently made a series of experiments on the relative efficiency of filtration, agitation with solid particles, and precipitation as a means of removing micro-organisms from water. The filtration was effected by columns, 6 inches in height, of green sand, silver sand, powdered glass, brick dust, coke, animal charcoal, and spongy iron. These substances were powdered sufficiently to pass through a sieve of forty meshes to the inch. It was found that only green sand, coke, animal charcoal, and spongy iron sufficiently removed the micro-organisms from the water filtered through them, and that the filters had to be renewed every month for efficiency. Coke and spongy iron occupied the first place. Water containing micro-organisms was also agitated with various substances in the same state of division as above, and after subsidence the number of organisms was determined. A gramme of substance was in general agitated with 50 cc. of water for 15 minutes. In all, the number of organisms was reduced; but with coke complete removal was effected. Precipitation by Clarke's process also reduced the number of organisms. Now, it would appear that ordinary boiling is not absolutely certain to destroy all microscopic life; and hence no water should be drank which has not been filtered. The drinking water in relation to parasites will be found in the proper chapter.

Coke, spongy iron, &c.

Coke.

Parasites.

Lime-juice. The necessity for lime-juice, as an habitual ration in the tropics, will be found fully pointed out in the chapter on Scurvy. Meanwhile it may be pointed out that for the native troops it was stated in the Afghan war that "the use of lime-juice need not be insisted on." This order is not in accordance with the experience derivable from native troops. Native troops are, as will be shown, peculiarly prone to scurvy in the field: and the folly of such an order bore bitter fruit to one native regiment in the Kurram Valley. I was on a committee to report on the state of this regiment, and scurvy had so thoroughly seized it that it had to be sent back to India, and thus lost all further chance of sharing in the campaign.

Tea, coffee, cocoa, chocolate. Tea, coffee and cocoa should be supplied in free quantity for all campaigns in hot climates. Cocoa possesses distinct nutrient properties in addition to the stimulant effects of tea and coffee. They all act on the nervous system, quickening the lagging powers, and restoring exhausted nature. Coffee and tea in addition protect the system against malaria. Coffee and cocoa are especially indicated: (1) for early breakfast before marching; and (2) for those on night guard. If cocoa only had anti-malarial virtue it would be a perfect food. Tea is especially indicated for the line of march, and at the end of a march. In

very malarial districts, coffee or tea should be given for breakfast: otherwise chocolate or cocoa. No grocery ration probably is more appreciated by the men than the latter. In the Sunjhie-ujong expedition, the morning meal of hot chocolate and biscuit was reported on as "one that could not be improved. At Fort Lydenberg in the Transvaal, rock cocoa was "simply invaluable." It is important, in order to get the full value of coffee, that the berries should be taken, in order that fresh coffee may be always ground. The example given in the Bohemian war might with advantage be followed. To every 250 men 12 coffee-mills were distributed.

I found nothing to equal cocoatina as a ration before the morning march. Cocoatina with some biscuit is quite sufficient to start on, as the appetite on walking is not yet lively. Nowadays cocoatina, coffee and milk are obtainable in a portable form, and there should always be a large stock carried. Cocoatina is best: it lasts longer, and is quicker in mixing.

A few cautions are necessary with regard to these beverages. Large quanties of strong tea are very apt to cause acidity and flatulence: hence, let not the brew be strong for the men's bottles. Again, Sir William Roberts of Manchester has shown that tea has an intense inhibitory action on the salivary secretion, whereas coffee and cocoa have this only in a slight degree. This inhibitory action can be removed by a pinch of carbonate of soda in the teapot. Again, all three, when strong, retard digestion. Now digestion is ever apt to get out of order on a campaign, hence let not the several infusions be too strong.

Tobacco.

The men should on no account be without tobacco. No deprivation is felt more. But the tobacco should be good. The only complaint the Russian soldiers made at Tchikishlar was the want of tobacco.

Condiments.

The tropical war ration should also be amply supplied with condiments, inasmuch as they remove the tastelessness of ration meat, excite secretion, and facilitate digestion. Vinegar, especially, should always be taken, on account of its anti-scorbutic properties. Olive oil also is indicated to supply any deficiency of fat there may be in the ration; in very many campaigns a rough salad has been obtainable from wild vegetables, and the oil would be admirably taken with it, or with the ordinary vegetable ration, especially where preserved vegetables are given out, for with them it would remove the dry papery taste. The citrates, tartrates, and lactates should be issued also as salt, as suggested by Parkes, for the prevention of scurvy.

Example of what a campaigning diet should not be.

In the foregoing paragraphs I have attempted to lay down the principles of a soldier's diet in the tropics, and what such a diet should be: I now conclude by showing what a soldier's diet in the tropics should not be. "In these days of Chicago beef, Australian condensed soups, preserved vegetables, and German army sausage, armies ought to be, and can be, well fed. The French troops were often for a fortnight together without meat, or wine, or brandy, or bread, and very often had to depend for

sustenance on paddy rice. The Intendance did all it could, but was starved for means, and the privations of the troops entailed great mortality. The provisions were infamous, and the meat bad." Now, one would suppose the above passage related to a campaign in early French history, say at the battle of Crécy: but this is not the case, it is a quotation from a correspondent writing on the Tonquin expedition of 1885.

DIET FOR NATIVE SOLDIERS IN CAMPAIGNS.

We, however, are not always blameless in dieting our armies. The native soldier could bear witness that at times he has experienced neglect. Whilst the rationing of the British troops was excellent in the Affghan war, I hold that the rationing of the native troops was deficient. This has not, however, been always the case. Let us see how our native regiments therefore have fared in campaigns.

Abyssinia, 1867-8. In the Abyssinian war the native ration consisted of—Flour or rice, 2 lb.; ghee, 2 oz.; salt, $\frac{2}{3}$ oz.; huldee, $\frac{1}{8}$ oz.; dhall, 4 oz.; sugar, 3 oz.; black pepper, $\frac{1}{8}$ oz.; meat, twice a week, 8 oz.

Looshai, 1871-2. In the Looshai expedition the ration was proposed as follows:—Flour, 2 lb.; ghee, 2 oz.; salt, $\frac{2}{3}$ oz.; chillies, $\frac{1}{6}$ oz.; tobacco, 1 oz.; dhall, 4 oz.; goor, 3 oz.; black pepper, $\frac{1}{8}$ oz.; tea, $\frac{1}{2}$ oz.; with onions or garlic, turmeric (huldee), coriander seeds, cloves, tamarinds. But this proposed diet was substituted by—Rice, 1 lb.; dhall, 4 oz.; salt, $\frac{3}{4}$ oz.; flour, 1 lb.; ghee, 2 oz. This diet was given to both native soldiers and camp followers, including coolies. On this diet the men soon began to complain of a "craving for meat." Now, the principal medical officer very properly pointed out that the greater part of the native troops were accustomed to meat, and to sugar, yet both were wanting. Moreover, the coolie and camp follower had the same diet as the soldier, yet the coolie's work was done at the end of the day, and he had only to sleep, whereas the soldier had to do picket duty, although during the day he carried* as much weight as the coolie. The following recommendation was therefore made: an issue of meat twice a week where procurable, or an extra ration of ghee or goor (sugar) when not procurable, to the meat eaters. That the coolies should have a ration of rum, and the non-spirit drinkers some bhang or opium.

Duffla, 1874-5. The rations for the Duffla expedition were—Atta, 2 lb.; ghee, 2 oz.; onions, 1 oz.; dhall, 4 oz.; salt, $\frac{2}{3}$ oz. For Mussulahs, in addition, pepper, $\frac{1}{6}$ oz.; huldee, $\frac{1}{6}$ oz.; and chillies, $\frac{1}{6}$ oz. A "dry" ration was also available, and was used on several occasions, more to satisfy a desire for change than from any actual necessity. Parched rice, 12 oz.; parched grain, 10 oz.; oil, $\frac{1}{2}$ oz.; ghee, 2 oz.; salt, 1 oz.; sugar, 6 oz.; tamarind, 4 oz.; chunam, $\frac{1}{4}$ oz.; rath, $\frac{1}{8}$ oz. Also for the few rice-eating people of the force, soopti (or dried fish) was taken. On certain days the men had a meat ration of

* The weight of the soldier's equipment was 41 lb. 7 oz.

goat's flesh, on which occasions the atta or rice was reduced one-half.

Besides the daily ration, 2 oz. of sugar or $\frac{1}{2}$ oz. of tea, free of charge, was allowed to each man in hospital, and to the rest of the troops and public followers on special occasions of fatigue or exposure to bad weather, and, in addition, one dram of rum. "These regulations were a great boon, and a means of arresting sickness." Issues of rum, tea, and sugar, according to preference, were thus made about twenty times during the campaign. About half the men preferred rum.

On Payment.—1 oz. tobacco and 12 gr. of opium were allowed to the men accustomed to these drugs, who would otherwise have fallen to pieces.

In the Afghan war the following scale was issued for the troops—Atta or rice, 2 lb.; ghee, 2 oz.; dhall, 4 oz.; salt, $\frac{3}{4}$ oz. And for the followers and coolies—Atta or rice, 2 lb.; ghee, 1 oz.; dhall, 4 oz.; salt, $\frac{3}{4}$ oz. Doolie-bearers were only allowed the same amount of ghee as a camp-follower, who might probably do nothing, whilst the native soldier only had one more ounce of ghee. It was laid down in addition that "meat might be issued to the native troops on payment;" also, on payment, huldee, chillies, pepper, and other spices, opium, bhang, whilst the "issue of lime-juice need not be insisted on, although it appeared desirable that some supply of this article should accompany the troops to meet possible requirements." These words appeared in the medical précis distributed to each medical officer at the outset of the campaign. I shall return to this anon. Afghanistan, 1878-80.

In Egypt, 1882, the excellent, healthy, and substantial rations granted to the native troops under the principal medical officer, Dr. Colvin Smith, C.B., were as follow:— Egypt, 1882.

(1.) *For the Cooking Men.*—Rice, $1\frac{1}{2}$ lb., or flour $1\frac{1}{2}$ lb.; ghee, 2 oz.; dhall, onions, or potatoes, 4 oz.; salt, $\frac{1}{2}$ oz.; garlic, $\frac{1}{16}$ oz.; sugar, 2 oz.; mustard oil, 4 oz.; water, 1 lb.; turmeric, $\frac{12}{61}$ oz.; black pepper, $\frac{1}{8}$ oz.; chillies, $\frac{1}{8}$ oz.; coriander seed, $\frac{1}{8}$ oz.; cummin, $\frac{1}{8}$ oz.; *every third day fresh mutton*, 4 oz; firewood, 2 lb.; lime-juice.

(2.) *For the Non-cooking Men.*—Ghee, 3 oz.; onions, 2 oz.; tamarind, 2 oz.; salt, $\frac{1}{2}$ oz.; garlic, $\frac{1}{16}$ oz.; sugar, 6 oz.; mustard oil, 4 oz.; water, 1 lb.; powa, 1 lb.; parched grain, 8 oz.

(3.) *Articles on Payment.*—Goor, 2 oz. for cooking, $3\frac{1}{2}$ oz. for non-cooking, men; rum, 1 dr.; tobacco, $\frac{1}{2}$ oz.; opium, 20 gr.

In the Aka expedition the men received flour, 2 lb.; *or* rice, $1\frac{1}{2}$ lb.; dhall, 4 oz.; ghee, 2 oz.; salt, $\frac{2}{3}$ oz.; onions, 1 oz.; pepper, $\frac{1}{6}$ oz.; chillies, $\frac{1}{6}$ oz.; turmeric, $\frac{1}{6}$ oz. Also once weekly, *meat*, 1 lb.; *rum*, 1 dram; *amchur* (mango), 1 oz. An extra dram of rum was issued on special occasions, and also given to the men on ferry-work on the river. Aka, 1883-4.

Lime-juice was not issued, on account of the abundance of the wild anti-scorbutic plants and fruits obtainable.

It is to be remarked that there is no sugar in this ration. This, with only one issue weekly of meat, would appear to be the only defects.

Now, out of these six campaigns, it will be seen that in three there was no meat issue, and in four no sugar issue; that very little difference is made between the coolie and the soldier; that lime-juice, or its substitute, is not always provided for, being omitted in four out of the six campaigns; and that in the hardest campaign of all, with the teachings of previous campaigns to learn from, the ration was the worst. However, before commenting on a native soldier's diet, we will examine his race prejudices in respect to diet.

The following are the castes usually found in native regiments (Ranking):—

A. Hindoo.	*B. Musalman.*
1. Brahmin.	1. Shaikh.
2. Chutri or Rajpoot.	2. Syed.
3. Bais.	3. Moghal.
4. Sudr.	4. Pathan.
5. Sikh.	

As regards the Hindoos, none of the first four classes will eat eggs; the first three will not use wine; the fourth will drink wine, and will eat all flesh meat except beef. The first four classes are comprised under two sects, of which the Bishau sect will not take either wine, flesh, or eggs; the Sunasi sect will eat flesh, except beef, but not eggs or wine.

The Sikh will eat or drink anything, but will not touch tobacco; but they are precluded by their religion from using bazaar meat killed by a Mahomedan butcher.

The strict Musalman will not use wine; they will eat every kind of flesh except that of the pig.

So much, then, for their laws. Now let us see what the people do in practice. Pathans consume, as a rule, every other day, about 8 ounces of mutton or goat's flesh. The other Mahomedan and Hindustani Sepoys eat the same quantity about once a week. The Muzbi Sikhs will eat meat whenever they can get it, and they all take milk. Now such being the case regarding their diet in peace, we find that, in the Afghan war, the men were granted a diet in which meat was wholly absent. True, Government stated that the men might buy meat; but, as a matter of fact, although willing, in the Kurram Valley they were mostly unable to do so, for the commissariat department monopolized nearly all the meat for the British troops. We do not know how the men fared in the other columns, but this was the case in the Kurram Valley. Moreover, why should the native *have to buy his meat?* The British soldier has not to do so. And what was the value of this field ration of flour, 2 lb. dhall, 4 oz., ghee, 2 oz., salt, $\frac{3}{4}$ oz. It has been calculated in the Bengal Army reports. Let us compare it then with the average diet given by Parkes for a soldier on service:—

	(1) Parkes' Diet for a Soldier on Service.		(1) Afghanistan Diet for a Soldier (Native) on Service.
Albuminates	6 to 7 oz.	...	4.37 oz.
Fats	3.5 to 4.5 ,,	...	2.38 ,,
Carbohydrates	16 to 18 ,,	...	24.79 ,,
Salts	1.2 to 1.5 ,,	...	1.33 ,,

And as regards nitrogen and carbon :—

	(2) Dr. Chaumont's Diet for a Soldier on Service.		(2) Afghanistan Diet for a Soldier (Native) on Service.
Nitrogen . .	350 to 450 grains	...	303.44
Carbon . .	5500 to 6500 ,,	...	6654.98
(3) *Parkes' proportion* of N : C			1 : 15
(3) *Afghanistan ratio* of N : C			1 : 22

It is thus seen either that the theory of diet advocated at Netley is erroneous, or that the native soldier was insufficiently and improperly fed in Afghanistan. Prof. Du Chaumont has shown that at home the ordinary ration of the British soldier "has the following fundamental errors: the albuminates are *deficient;* the fats are *very deficient;* the starches are *somewhat in excess;* the salts are *rather deficient.* In a similar manner the native soldier's ration in Afghanistan had the following fundamental errors: the albuminates were *very deficient*, being only two-thirds of the required standard; the fats were *very deficient*, being only three-fourths of the required standard; the starches were *enormously in excess*, being half as much again as they ought to have been; and the salts were *slightly deficient.*

To return to the Afghanistan ration. There is yet another defect; it contained no anti-scorbutic; the consequences will be detailed in the chapter on Scurvy. Suffice it to say that scurvy affected several regiments, one from this cause having to be sent back to India early in the campaign. The men, moreover, complained of the want of variety, for an Indian soldier as well as a British has a sense of taste. At length, in March 1880, in the Kurram Valley, a meat ration was ordered by General Watson, and the following additions were made, and at length allowed: meat, 8 oz. twice a week; vegetables, 8 oz. twice a week; tea, 2 oz. twice a week; rum, 4 oz. twice a week for Hindoos and Sikhs; rice, 2 lb. once a week instead of the atta ration; goor, 2 oz. It must be remembered that the up-country regiments are either Sikhs or Punjabi Mahomedans, and as such require meat and get it in peace; one can understand then the deleterious effect of their being deprived of it in war. Now the ration for the Indian contingent is excellent, and it is hoped that such a ration as that issued for Afghanistan will never again occur. It was a distinct retrograde ration; for the medical authorities had the excellent ration for Abyssinia to guide them, and the warnings of the principal medical officer at Looshai.

A few concluding remarks will now be given, as the subject of the Sepoy's diet is again fully entered into with reference to scurvy in the appropriate chapter, and it is only necessary to draw attention to some of the principles and facts on native rations for guidance.

Amongst certain classes there is a prejudice against eating fresh meat; here then supplement the diet with tamarinds, onions, potatoes. But the idea of such prejudices is not one to be encouraged. The Vedas show that the ancient Aryans were neither vegetarians nor total abstainers, for the flesh of wild cattle is Class prejudices.

allowed, and the flesh of the cow is praised as the best of food. It would be well to select for the hard fighting work of a campaign only meat-eating Punjab regiments. Again, it has been urged that no difference should be made in the food of the coolie and of the Sepoy; we however hold that both should be fed up to their work; but it is absurd to say that the Sepoy does not require more food than the coolie. The Sepoys of the 23rd Regiment carry into action 41 lb., in marching order 38 lb. The coolie's load is not more than this, in fact not so much in many cases; but the latter's work is done when the day is over, whilst the native soldier has many other duties to do, of pitching his camp, sentry-go, &c. Hence the soldier decidedly wants a better diet than the coolie. Again, study the habits of the material in peace. Some regiments are accustomed to rice, such cannot take attah; this is especially the case on the north-east frontier. The coolies in the Looshai campaign were accustomed to live on rice and dried fish; they were given attah, which they mixed with water and consumed raw, and consequently began to suffer from bowel complaints. Again, in the Aka campaign, the followers suffered much more than the troops from diarrhœa, due to this unusual ration. The grain food must be well cooked. In the Zhob Valley bowel complaints arose from the imperfectly cooked dhall, added to the large quantity of bran present in the locally procured flour. Hence, see that the flour is unadulterated. It is also of the utmost importance that a good allowance of condiments be given to the native soldier. He has been accustomed to condiments all his life. In Looshai there was a great want, or rather an absence, of condiments, leading to bowel complaints. The 22nd Native Infantry suffered severely in this respect. Hence, give spices, pepper, &c. Let sugar always be a portion of the diet. Let also a liberal ration of tea be granted, as there is nothing the native likes so much.

Sepoy's diet to be better than coolies.

Local habits.

Cooking.

Condiments.

Tea.

Indian hemp.

Indian hemp should not be given. It was recommended in Looshai and taken, and could be obtained on payment in Afghanistan. In the Peshawur Mountain Battery, the right detachment consisted in Looshai of Musalmans, the left of Sikhs. Now bronchitis prevailed amongst the right detachment, but was quite absent in the left. Dr. Johnston, who was in charge, considered the cause to be due to the hemp and tobacco taken solely by the men of the right detachment. From our experience tobacco is favourable for a campaign, and we think that the hemp was the exciting agent here.

Indian corn.

Natives are very fond of Indian corn. They should be cautioned not to drink largely of water before or after taking it raw. In General Roberts' march, three native soldiers died from obstruction of the bowels which was held to be due to their having eaten largely of raw Indian corn and of having drank copiously at the same time of water. The force also, as regards the Sepoys, suffered much from colic from this cause.

Tobacco.

The native soldiers, except the Sikhs, will take tobacco, and a ration should be provided. Both to British and to native soldiers,

tobacco if good, is a solace after the day's work is done. The men are accustomed to it in peace, and they should have it in war. But the quantity should be regulated, and the quality good.

The issue of a spirit ration is indicated in campaigns for native soldiers on the same occasion as for British. There is indeed a certain amount of evidence that native soldiers, especially Hindostanis, are all the better for a regular ration in malarious regions. Dr. White, of the 42nd Assam Light Infantry, states, as the result of great experience, that alcohol is an essential article of diet for climates like Assam, and "one of the best means of preserving health." He brings statistics to prove that spirit drinkers in the native troops enjoy as good health as in the most salubrious stations, whilst abstainers suffer inordinately.* The mortuary returns of imported labourers on planters' districts show the same. Low caste Bengalees, he points out, are all spirit drinkers, and enjoy as good health if not better than in their own village, whilst the non-spirit consumers amongst Bengalees and Hindostanis have been subject to a continuous and appalling mortality, exceeding 20 per cent. per annum. Finally, Dr. White, holding that inasmuch as evidence of this sort has ceased to be a matter of theory, urges that the State is bound to supply to native soldiers a pure spirit at a reasonable price, as he holds it to be an actual necessity of life. This evidence is corroborated by Dr. Veale, of the 30th Punjab Native Infantry, for his regiment. He holds that Government should issue sound spirit to all native troops proceeding on service, as "conducive to health and discipline." This evidence is an excellent commentary on the *ex parte* statement "that all medical experience is against the use of alcohol for natives." But as far as our own experience goes alcohol is not thus needed in climates like that of Afghanistan, although it may be so in damp, tropical climates.

Alcohol.

Dr. White's evidence.

Dr. Veale's evidence.

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* Compare also the before-mentioned statistics of the Malay war.

CHAPTER IX.

THE BIVOUAC.

One advantage of selecting the cool season in hot countries is the possibility of bivouacking, or of making expeditions without having to carry tents. This is, of course, of immense advantage where a rapid blow has to be struck. Bivouacs are attended with a remarkably good state of health of the men also. Under this heading we include all expeditions in which no tents were carried, the troops either having to sleep in the open or to take advantage of any shelter they could seize.

New Zealand, 1864–6.

In the New Zealand war, in January 1864, the force operating on the Waipa River marched out without camp equipage, each man carrying two days' provisions, for Terore. The weather "was intensely hot and suffocating." The men endured the fatigue well, without any injurious influence on their health. They formed *tentes d'abri* with the blankets and branches of trees. For five weeks they were without any other equipment, and they remained in perfect health, till towards the end of this period, when some bowel affections began to appear.

Again, part of the column under General Chute (of 425 men), operating on the west coast, made a circuit of the Taranaki district of 400 miles, in the height of the hot season, without tents. There were the most perfect health and condition, although the men were short of food and constantly wet, lying on damp ground at night in the midst of dense forests. At one time they were reduced to horseflesh; at another they were soaked by rain for four days, yet *there were no sick.* This remarkable result was due to the "early morning marching and good morale."

China, 1860.

In the China war of 1860 the men bivouacked for some days at Sinho, on the causeway of that place, raising themselves off the ground on heaps of hay. Though there were marshes all around, yet the general health was good throughout. But, as we have seen, the men were selected, and the period was early in August, when the height of the hot weather was over.

N.E. frontier.

In the campaigns of the north-east and north-west frontiers of India the men, though not taking tents, have hutted themselves. Still, before huts were built, the men had to bivouac. On these occasions the importance of sleeping off the ground has always been evinced.

Malay, 1875–6.

In the Malay expedition no tents were taken; the men slept under any makeshift.

Jowaki, 1877–8.

Again, in Jowaki, the same occurred, yet the health of the

troops was excellent, notwithstanding the inclement weather. Wherever possible, advantage was taken of village huts, but as often as not the troops were in the open.

Advantages of the Bivouac.—There can be no doubt that the bivouac possesses one great advantage. The elements of overcrowding and deficient ventilation scarcely come into play. And whilst there is this negative advantage, we have the corresponding benefit of a life in pure air.

The Disadvantages, nay, dangers, arise from the unequal temperature of the night and day. This, as in Egypt, is very great. Desgenettes, quoted by Morache, states that the men who had bivouacked, had to employ every means for re-warming themselves on waking. Again, the dew is likely to cause chills. During the day the sun may bring on fever or sunstroke. Still, notwithstanding all these possible results, the men have enjoyed most remarkable health.

Rules for Bivouac.—As far as the English army is concerned, bivouacs have been chiefly in wooded districts, and hence some kind of shelter has been available. Even if only a shelter from the breeze at night be formed, much benefit will ensue. Such a shelter can be easily made in a few minutes by forked boughs, &c. Again, a cardinal rule is never to sleep directly on the ground. Excellent "machans" were made in some of our north-eastern frontier campaigns thus:—Three logs were placed parallel to one another about 3 feet apart; over these split bamboos were fastened down by a cross-piece over each log, and bound with creepers; next a heap of bamboo leaves, and over the whole a waterproof sheet.

The "machan."

Again, by clubbing the blankets or waterproofs, two upright bamboos and a ridge-pole would allow a blanket or waterproof to be stretched over, and thus a good protection formed.

In all bivouacking expeditions the men should have *two* blankets. In some of our north-eastern frontier campaigns the want of a second blanket has been severely felt. A waterproof sheet, also, should never be absent. In addition, a piece of oiled light canvas with eyelet-holes at the sides should be supplied to each man. Thus he would have a waterproof and blanket to lie on, a blanket to cover him, and, by clubbing with his fellows, a *tente d'abri* could be formed with the canvas.

Finally, in bivouacking, *the importance of never having a cotton shirt next the skin is imperative.* Wool should always be worn.

CHAPTER X.

CAMP FOLLOWERS.—TRANSPORT CORPS.—HORSES, ETC.

THE precautions in connection with camp followers must be on the same general lines as those for the fighting element. They must be properly selected, fed, and clothed.

Aka, 1883-4.

Selection.—Selection is especially necessary. In the Aka field force, the coolies from Golaghat were cachectic and anæmic, and had previous to the campaign been employed in a malarious country. *They were not medically inspected before the campaign, and fully one-third broke down.* The men who had only passed one season in Assam were most sickly; men of longer service were stronger, better nourished, and enjoyed, therefore, better health.

Afghanistan, 1878-80.

In the Afghan war, owing to the great demand for coolies for transport and other purposes, many were engaged quite unfit for service. A large number soon broke down. On the advance of the battery to which I was at first attached, a large number had to be weeded out from those delivered over to us for employment.

Zhob Valley, 1884.

In the Zhob Valley expedition, the health of the followers was only fair. They are reported on by the principal medical officer as a "scratch pack." Not being trained kahars, the dooly-bearers suffered from general debility. Only four men also being allotted to each dooly instead of six, they were not equal to the work, and dandies had to be substituted for doolies.

Transports.—Where camp followers have to be transported by sea to the scene of action, especial care must be taken that each man has sufficient space; if not, sickness inevitably arises.

China, 1860.

Thus, in the China war, Dr. Rennie points out how overcrowding on board the transport *Winifred* caused a break-down. Here the overcrowding was such that fully one-third more men than there was space for were crammed between decks at night. "Fever" arose and much sickness.

E. Soudan, 1885.

In the s.s. *Darien*, for the Eastern Soudan in 1885, the followers were very crowded. Here the voyage lasted only eleven days. 950 men were lodged in a space that would have been fairly crowded with only 600. Although every space was utilized, yet the men overlapped one another when sleeping. In spite of this, the men who cooked their rations did well; but with the non-cooking men great sickness arose. With reference to this Dr. Hendley draws the obvious conclusion that if in any future expedition non-cooking men are engaged, they should be persuaded to take cooked food, or this should be insisted on in the engagement of the men.

The ration must be generous. This is especially necessary in such expeditions as the recent Burmese war. Here, on the first advance to Mandalay, no mule carriage was taken; consequently, coolies formed the mainstay of the advance. Food.

The precautions especially to be taken for coolies with reference to certain tropical diseases, as cholera, relapsing fever, and others, will be detailed in the respective chapters. Relation to tropical diseases.

Horses, likewise, require sufficient space. In the China war of 1860, on the ship *Kate Hooper*, a serious break-down occurred from overcrowding, 70 horses out of 250 on one day alone having to be thrown overboard. Horse transport.

CHAPTER XI.

CONSERVANCY AND DISINFECTION.

We have already considered the conservancy of the camp as regards detritus and rubbish; the management of the excreta remains.

Latrines.—All manure heaps and latrines must be placed on the opposite side of the camp to that of the prevailing wind, and at some distance from it—at least 50 to 100 yards from the tents. There should be separate trenches for urinals from 20 to 25 yards long. The trenches should be deep rather than wide, for, if too wide, there is a broader exhaling surface. Fæcal odours travel farther than any odours of putrefaction. Pein states that the islands of Chinchas, being covered with guano, can be smelt 5 or 6 leagues off at sea; Levy also draws attention to the causation of dysentery by odours from badly looked after latrines. The excellent rules for trenching in the Punjab gaols can be followed with advantage in campaigns, as in both large bodies of men have to be provided for.

Trenches. All trenches are to be 1 foot deep and 1 foot wide, with a space of 1 foot between each line. The trench, when filled to within 6 inches of the top with fæcal matter, is to be filled up with earth to the extent of 8 inches. Only a sufficient extent of trench is to be dug for one day. Sticks of wood can be placed across for the men to stand on. On arriving at any camp, the trenches should at once be dug, screened off from the camp, and their places indicated by flags. A mehtar should be always on duty to cover in and disinfect the fæces, and a non-commissioned officer should be told off to see that he does his work properly. Dry earth is to be sprinkled over the urine.

Conservancy is especially needed in damp tropical climates. Surgeon-Major Johnson in his medical history of the Aka campaign insists on this, "for any want of care is more apparent than in a drier country." Where there is rank jungle, as on the north-east frontier, on arrival in camp a fatigue party must be told off to clear a place for the latrines and to dig trenches forthwith.

Pits. Sir Thos. Crawford holds that pits 4 or 5 feet deep are preferable to trenches in standing camps on the line of communication, small quantities of soil being added to the ordure thrice daily, and being disused when within 2 feet of the ground. By this method, certainly, there would be a less exhaling surface. They should be well banked up on being filled, so as to show their site.

The greatest care must be taken that the locale adopted for the

pits or trenches should be perfectly remote from the drinking-water source.

Rules.—At all standing camps and depots, no soldier or camp follower should ever be allowed to go elsewhere than to the allotted place. There should be separate latrines for soldiers and camp followers. Before any detachment leaves its camping ground, all trenches must be carefully filled up. The trenches are never to be dug in or near any water-course. Finally, in sandy soils, especially where the earth is easily blown off, leaving the trench open, the excreta had best be burnt. Prof. Du Chaumont would burn all excreta, but this would not be always practicable. But where not burnt, it should be a matter of routine to disinfect all excreta, whether specific or not.

Rivers.—The men should never use rivers in lieu of trenches, even if the nearest camp be miles away. Parkes shows the distance to which fæcal matter may be traced. Circumstances may, however, compel this course, as in Looshai, where some of the camp grounds were too confined to allow of the trench system. Here bamboo sheds were erected over the river, and fortunately the latter was a swift stream. Again, in the Malay country, similar arrangements had to be made. Here again it is related that the fish were so numerous as to seize all the ordure as soon as it reached the surface of the water.

Looshai.

Malay.

The men of the Pioneer regiment in Shank Gorge, Kurram Valley, were not allowed to use the mountain stream rushing through the narrow gorge, but proper trench arrangements were made for them. This stream was a source of drinking water to the camp below, which, although four miles distant, would, we think, have suffered had the water been polluted.

Afghanistan.

Kurram force.

I have before remarked on the good conservancy of the Kurram Valley, and contrasted it with the fæcal odours and putrefactive smells of some of the camps on the Candahar side, notably Kila Abdoola. Certainly the Pishin Valley soil was sandy; still, disinfectants might have been used and a camp sanitary officer appointed.

Candahar force.

Transports.—The question of conservancy on transports and coolie boats on the north-east frontier will be found in the chapter on Cholera.

Animals.—All dead animals without doubt should be burnt if possible. To bury them properly requires more labour than can be given on a campaign. According to my experience, the burying of camels in the Kurram Valley was a failure; the spots of burial (and they were many) were always specially indicated by the sense of smell to the passer by. At any rate, bury only the viscera, and burn the trunk. If there is not time for either burning or burial, Sir Thos. Crawford recommends stabbing the body in several places to give exit to gases and entrance to air. Or the carcass may be removed half a mile from the camp, and cut in pieces or blown up with gunpowder.

Disinfection.—I now come to the subject of disinfection as applied to campaigns in hot climates. I hold that all excreta,

whether specific or not, should be disinfected before being buried. Besides the treatment of the excreta, we must consider that of the bedding, tents, and general environment of the sick.

Disinfectants.

Let us first choose our disinfectant. Now, in military surgery we want not only disinfectants, but also antiseptics.* It is important at the outset to clearly define the two. By *disinfectants* or *germicides* we destroy the specific infectious poison which gives rise to the specific infectious disease: by *antiseptics* we do not necessarily do this; we arrest septic processes and putrefactive decompositions, but we do not necessarily kill the organisms. The metallic salts may prevent the multiplication of germs, but they will not kill them. So much for the definition. In choosing our agent, it will be found that, although there are remarkable discrepancies concerning the powers of very many of the common disinfectants—so-called—in use, yet there is a united testimony in favour of one agent—viz., corrosive sublimate. This agent, then, not only on account of its intrinsic value, but also on account of its magnificent antiseptic properties on wounds, and finally on account of its cheapness, I hold to be *the* agent for war. It may be well to show on what ground the exceeding value of corrosive sublimate is based.

Antiseptics.

Corrosive sublimate *the* agent.

In the matter of prevention of the reproduction of organisms, for supreme safety we must use an agent that will destroy *the spores*. The latter have an enormous resisting power, much greater than that of the fully developed bacteria. In infectious diseases we have rather to aim at destroying the infectious material than to hinder the development of the germs *after* they have arisen. The first experiments on the respective powers of drugs for destroying the spores completely were made by N. de la Croix, who established the great power of corrosive sublimate in this respect. He was followed by Koch in an elaborate research, the first portion of which was to ascertain whether certain disinfectants were capable of destroying the resting spores† of bacilli; every disinfectant was to be removed from the list of disinfectants which should be used in infectious diseases when it cannot destroy the developing powers of the resting spores. After testing various agents, Koch found the only certain disinfectants to be chlorine, bromine, and corrosive sublimate; and he held that in all places where neither heat nor gases are available corrosive sublimate should be used. He found that a 1 per 1000 solution killed resting spores in ten minutes, whilst simple moistening only of the earth containing the spores with this solution is sufficient to arrest their powers of development. Also that, according to length of exposure, solutions of from 1-1000 to 1-15,000 would kill micro-organisms. Now, any poisonous action of such diluted solutions may be disregarded.

De la Croix.

Koch.

The experiments of Arloing, Cornerin, Thomas, and Lyons,

Arloing, Cornerin, Thomas, Lyons.

* That is to say, there are occasions in which an *antiseptic* will be sufficient—*e.g.*, where we have only to deal with putrefaction.

† Koch experimented on the anthrax bacillus.

again, placed corrosive sublimate at the head of the list of efficient agents as regards their destructive power on the various morbific germs. They experimented with the infectious principle of anthrax, and found that 1-5000 solution destroyed its dried organism.

An elaborate paper by Sternberg gave the same results. He set about to determine (1) the exact value of germicides with a view to the destruction of organisms; and (2) to compare this value, established by laboratory experiments, with the results of clinical experience, so as to find what support the germ theory of disease receives from modern therapeutics. The steps of his investigation need not be detailed here; he experimented on five different kinds of bacteria—viz., the micrococcus of pus from gonorrhœa, from acute whitlow, from septicæmia, bacterium termo, and the bacterium of broken-down beef-tea. The following, then, represent his results as regards the action on the gonorrhœal micrococcus:— Sternberg.

	Results according to Germicide Value.	*Efficient in Proportion of*
Mercuric chloride	0.005 per cent.	1 part in 20,000
Potass. permang.	0.12 ,,	,, 833
Iodine	0.2 ,,	,, 500
Creasote	0.5 ,,	,, 200
Sulphuric acid	0.5 ,,	,, 200
Carbolic acid	1.0 ,,	,, 100
Hydrochloric acid	1.0 ,,	,, 100
Zinci chloridi	2.0 ,,	,, 50
Tr. ferri perchlor.	4.0 ,,	,, 25
Salicylic acid dissolved in boracic acid	4.0 ,,	,, 25

The following agents were shown to have *no* germicide value :—

Fowler's solution	in proportion	of	40	per cent.
Sodium hyposulphite	,,	,,	32	,,
Ferric sulphate (saturated solution)	,,	,,	16	,,
Liq. zinci chloridi (Squibb)	,,	,,	8	,,
Zinci sulphate	,,	,,	20	,,
Boracic acid (saturated solution)	,,	,,	4	,,

He next proceeded to determine whether he could generalize from this one bacterium to others. He found then that with the next three bacteria mentioned above, the germicides had the same practical value, whilst the practically valueless agents with the pus micrococcus were also practically valueless with the other bacteria. The micrococcus of broken-down beef-tea proved, however, much more resistant to all the agents, *except* the *bichloride of mercury and iodine.* These two agents Sternberg considers, then, to be germicides of the highest value, and would be certainly efficient in the proportions of 1-5000 and 1-200 respectively.

Lastly, the *Proceedings* of the Edinburgh Royal Society published in 1884 contains an account of a research by Wynter Blyth on the germicide power of the agents in ordinary use, and the results throw serious doubt on their value. But he has since stated that corrosive sublimate was to be most relied upon, inas- Wynter Blyth.

much as, when not destructive of the spores, "it poisoned them in a manner not essentially different from the lethal poisoning of a higher form."

Summary. There is thus on all sides overwhelming testimony to the value of corrosive sublimate. Yet, strange to say, it was not even recommended at the late sanitary conference at Rome. Dr. Koch himself, it is true, hesitated to recommend it because, if for general use, danger would come in; but Dr. Sternberg considered this danger exaggerated, as in dilute solutions its metallic taste would prevent the swallowing of a fatal dose, whilst if coloured by the addition of potassium permanganate, as recommended by the American Public Health Association Committee on Disinfectants, or by the aniline dye as practised by Sonderegger, no one would mistake it for a harmless mixture. Hence, I think it peculiarly indicated for war for the following reasons:—(1) Its certainty and superiority over all other germicides (except biniodide of mercury, which has lately been found by Dr. S. Miguel to be three times as powerful); (2) from its cheapness; and (3) from its being certainly the best surgical application for wounds, and thus one agent need only be supplied for all purposes. Before indicating its mode of application, I will take a brief glance at some agents that have been of some repute.

Carbolic acid. Carbolic acid, besides being as objectionable for its poisonous properties as corrosive sublimate, is far more expensive, less portable, and far less powerful, as is shown by Dr. Sternberg. Dr. Koch, in his experiments, found that a 5 per cent. solution was without effect in destroying the spores and bacilli of splenic fever even after exposure of 110 and 70 days respectively.

Metallic salts. As will be pointed out under Cholera, the metallic salts, with the exception of cupric sulphate, are valueless. Koch has shown with regard to zinc chloride that, in spite of the prevalent opinion that a solution 1 in 1000 is a safe disinfectant, even a 5 per cent. solution failed within a month to weaken the developing power of anthrax spores. Sternberg shows that the value of a solution of sulphate of iron and sulphuric acid in water, so extolled as a disinfectant, depends only on the sulphuric acid; and to ensure the germicide action, the solution must be used in at least the proportion of 5 per cent. for two hours. He also states that chloride of zinc failed as a disinfectant in the proportion of 8 per cent.

Dry earth. Independently of the fact that we cannot always get dry earth, and that moist earth would be worse than useless, its disinfecting power is small, and may be *nil*. Instances of this will be found in the chapter on Enteric Fever. Pasteur found that the soil containing the carcass of an animal that had died two years before of anthrax still contained the specific bacteria of this disease in a flourishing state of vitality. Dry earth, of course, is required to throw over the excreta, but reliance must not be placed on dry earth alone for security. Sir Thos. Crawford gives 3 lb. daily per head as requisite for efficient working.

Chloride of lime, carbolic acid. A double solution of chloride of lime and carbolic acid was recommended by the sanitary conference at Rome for cholera. I have

accordingly stated these recommendations and appliances for cholera; at the same time, I have shown that carbolic acid is far inferior to corrosive sublimate; whilst for complete destruction of all the organic matter in the air, so much chloride of lime is required as will render the air irrespirable by men. For thorough disinfection, therefore, the bulk required of these agents is against their portability in war.

In summing up the results of experiments, we find De la Croix stating that the only efficient disinfectants are corrosive sublimate, iodine, bromine, and chlorine; Steinberg, corrosive sublimate and iodine; Koch, corrosive sublimate, chlorine, and bromine. By all, corrosive sublimate is given the first place. And for the general purposes of war, corrosive sublimate seems to be the agent to be selected. Having determined this, we have next to indicate the solutions. Sternberg's proposal of combining corrosive sublimate with permanganate of potash has not only the merit of preventing disaster, but also of adding a deodorant to the solution, as bichloride of mercury has no such power. No chemical reaction occurs between the two. Summary.

For war three solutions would be required of corrosive sublimate:— Three solutions.

1. 1 in 1000 for bedding, clothing, tent walls, sheets, hands, and instruments. This solution destroys spores, provided there be sufficient time for exposure.

2. 1 in 10,000 for continuous application to wounds. This solution will destroy micrococci in active growth when not containing spores.

3. 1 in 500 with same quantity of potassæ permanganas for liquid fæcal discharge, solid fæces broken up, vomit, urine, sputa (of infectious pneumonia). The time of exposure to the solution to be one hour. A pint of the solution to be used for the disinfection of each discharge in cholera, typhoid fever, yellow fever, &c. The sputa should be received into a cup containing this solution.

The articles disinfected by No. 1 solution must be thoroughly soaked in it by sluicing, sponging, &c. Clothing and bedding which cannot be thus disinfected had better be burnt; this is the best way to treat all articles of little value.

There is yet another agent which has been used with success, but concerning which there is still much controversy. Still, there is a large amount of evidence in its favour, notably that of the late Dr. Evan Buchanan Baxter and Prof. Vallin. It would require no small amount of dogma to upset the authority of Dr. Baxter with his former pupils; and, as one, I would add sulphurous acid to the armamentarium of disinfectants. Sulphur is cheap, portable, and, I believe, effective. It is, moreover, admirably adapted for disinfecting huts in native villages, rooms set apart for hospital wards in any locale at the base, and tents. Dr. Baxter has shown that, by its greater solubility, sulphurous acid is preferable to chlorine for the disinfection of liquid media; but it is only as aërial fumigation we would employ it in war. "When aërial disinfection is resorted to, the probability that the

Aërial disinfection.

Sulphurous acid gas. Dr. Baxter.

virulent particles are shielded by an envelope of dried albuminous matter should always be held before the mind." Chlorine and sulphur dioxide "are both of them suitable agents for the purpose: the latter seems decidedly to be the more effectual of the two." Besides Dr. Baxter, De la Croix and M. Vallin have had most encouraging results. M. Vallin submitted the infective material of glanders and tubercle to the action of sulphurous acid gas, and in every case the virus ceased to be inoculable. He also states that the extreme resistance offered by anthrax spores is overcome by the gas before that of the harmless spores contained in garden mould. He is decidedly in favour of sulphur dioxide in practical work: "Sulphurous acid obtained by the combustion of sulphur in free air occupies almost the first place among the veritable disinfectants." Finally, Pettenkofer points out how the gas will penetrate every crevice, and considers it "to be one of the very best disinfectants."

M. Vallin.

I would therefore use this agent where it is not possible to thoroughly wash all the surfaces of tents, rooms, &c., with which infectious material from a patient may have come in contact.

Method of procedure.

All spaces to be fumigated must be carefully closed as tightly as possible. Then obtain the measurement of the space. The necessary amount for space is said to be in the New York regulations 5 drachms for each cubic yard. A room of 25 cubic yards requires $1\frac{1}{4}$ lb. of sulphur. According to the Punjab Gaol Manual, each grain of sulphur, producing 3 cubic inches of the gas, is sufficient to disinfect 20 cubic feet of air; or $2\frac{1}{2}$ oz. would be sufficient for 2232 cubic yards. The amount given in the New York regulations is extreme; the amount for the Punjab Gaols has been tested by epidemics and found sufficient and efficient. In fumigation of the space in which an infectious individual has lain, for additional security his bedding and clothes can be laid on the floor, but this should not supersede treatment by corrosive sublimate. The space should be fumigated for six hours.

Other measures.

The various other preventive measures as regards attendants will be found in the respective chapters. In conclusion, I would urge that, inasmuch as in the case of enteric fever, cholera, and many other camp diseases we cannot always diagnose the first case, and inasmuch as we cannot say when a "bowel" affection has passed into the infecting stage—that it should be a matter of routine practice in the field to disinfect *all* excreta. And for this reason, if for no other, as large quantities of the chosen agent will be required, corrosive sublimate from its cheapness is indicated.

CHAPTER XII.

THE HYGIENE OF THE BATTLE-FIELD.

After a battle the army has to preserve itself and the neighbouring population from disease caused by decomposition of dead bodies. Both the soil and the air are infected. The air also is vitiated by the effects of the combustion of powder. As I have so often before urged, all the decomposition processes in the soil or air will be much heightened by tropical heat, so that the matter is one demanding much consideration for our present purposes. Hitherto our campaigns have not been attended with the slaughter pertaining to European battle-fields, but the day is fast drawing near when the situation in this respect may be changed. The choice of the disposal of the dead rests of course between burying and burning. Now it is at once evident that, physically considered, the disposal by burning is far easier of execution than that of burial, whilst in a hygienic point of view there can be no question of the advantages of cremation.

Burial.—Besides the labour of burial, how frequently is the ground unsuited for it? The light sandy soil of the Quetta-Candahar line was certainly not, nor the soil about Tel-el-Kebir. On my way out to India from furlough I visited the field of Tel-el-Kebir about three months after the battle. The dreadful odour of cadaveric putrefaction always indicated at that date the various places of burial along the lines of the entrenchment, although the bodies were all covered up. Again, I went over the scene of the fight at the taking of the Peiwar Kotal on one occasion at least eight months after the occurrence; the cadaveric odour was heavy and strong at the sites of interment. In rocky ground such as abounded in Afghanistan it was impossible, apart from the labour question, to bury the bodies deep enough. In instances such as these the results were innocuous, for no human tenements were at hand, but this may not always be the case; and we have no right in our wars to poison the atmosphere after the fighting is over. And this is no theoretical sequela. Desgenettes relates that after the retreat of the Mamelukes from Egypt an epidemic broke out carrying off large numbers of the people, due to the pernicious exhalations from the soil raised during the summer heats from corpses in course of putrefaction. And these exhalations are especially liable to rise from loose sandy or rocky soil. It so happens that some of the soils most frequently found in hot countries are just the soils in which the process of putrefaction is very slow, and hence longer poisoning of the air occurs. Objections.

In clay and alluvium, for instance, decomposition takes place very slowly; also in sandy and flinty soils; again, in rocky soils. And such soils are largely met with in the tropics. Thus, on every account, burial is not to be recommended.

Burial and quicklime.

We next have burial with quicklime superadded. Here, again, the labour question comes in; also the necessity for carriage of the lime; whilst as a result the body *is actually cremated*, only by a far more laborious and less effectual process.

Burial and carbolic acid.

Again, burial can be carried out, the body being enveloped in sheets impregnated with carbolic acid; this, however, would not be a speedy process after a battle, especially after a battle of the future, in which large numbers of dead will have to be disposed of. Of the methods employed at Sedan, that of incineration at the spot by tar, practised by M. Créteur, was, in my opinion, decidedly the best. The dead having been very hastily buried, the health of the neighbourhood seemed likely to be so prejudiced that a committee was formed. M. Trouet surrounded the exhumed body with a mixture of chalk, naphthalin, and carbolic acid, dug a deep grave, and re-interred it, raising a tumulus over the place. M. Créteur, on the contrary, did not re-exhume the corpses, but poured over them tar, which infiltrated itself amongst all the layers of corpses. He then lit the tar with straw moistened with oil of petroleum. The whole fossa containing the hastily buried bodies was lit up. So great was the intensity of the combustion that fossæ containing the largest number of bodies only required about an hour of the burning process. All cadaveric odour was at once dispelled; the column of smoke containing carbon and carbolic acid destroyed all insects, flies, &c., which were swarming over the field, and doubtless also the bacteria of putrefaction. Unfortunately, on account of the reclamation of the dead by their relations being rendered impossible by this method, the German authorities intervened, and this salutary process was stayed.

M. Trouet's method at Sedan.

M. Créteur's method at Sedan.

Cremation.—In the tropics we must dispose of the dead quickly. There is no time for hesitation with a hot sun overhead. Cremation should be the rule, therefore, for the future. It involves less labour, and at the same time removes completely all sources of putrefaction, whilst the smoke tends to purify the surrounding air. Circumstances must determine the method to be employed —(1) Prof. Du Chaumont advocates the use of ambulatory furnaces; (2) M. Pein advocates the method above detailed by tar and petroleum; whilst (3) the method employed by the German army in 1814, after the battle of Paris, would seem indicated in wooded districts. Here hearths were erected of stones, the dead placed on them in heaps and covered with faggots. In fourteen days 4000 corpses were burnt, at a cost of 2 francs per man. M. Créteur estimates the cost of his process per man at 15 centimes.

1. Du Chaumont; 2. M. Pein, M. Créteur; 3. Prussian method.

Dr. José Ennes' views.

The same course of action was advocated—viz., that of cremation —at the late London International Congress by Dr. Guilherme José Ennes, of Lisbon. He held that cremation was the only

absolute means of disinfecting the battle-field, and that disinfectants were absolutely useless.

The conquering army is bound, not only in the interest of the conquered and of the neighbouring villages or habitations, but also in the interest of itself and of its own wounded, to take every precaution in disinfecting the battle-field. This is especially the case in the tropics. Cremation answers every purpose: it leaves the soil disinfected; it disinfects the air; it renders the environment healthy for the sick and wounded on the spot; it is quick and decisive; and lastly, it recommends itself to Government as well as to sanitarians, for it is cheap, and cheapness occasionally in our military history has turned the scale against sanitation. Here, however, happily the two run together.

CHAPTER XIII.

THE HYGIENE OF BELEAGURED POSTS

We are unable to draw lessons from this portion of military hygiene to any extent, inasmuch as it has not often fallen to the lot of the British army to be in this position. Nevertheless, lately, in the Afghan wars, and in the wars of Natal and Transvaal, we were in this position. But Hygiene asserted herself.

The great danger in sieges arises from the constant sojourn on the same soil, involving both non-ventilation of the ground and simultaneously increasing defilement. With this also is generally added a greater compression of the population. In the end also come in the factors of scarcity of provisions, whilst over-shadowing all is the element of fatigue. Thus, we have all the great elements of army diseases—fatigue, insufficient food, compressed camp, and an impure soil. I have not been able to discover any medical histories of the siege of Lucknow or of Delhi, for we were in the latter as much besieged as besiegers; at Delhi, however, there was free ventilation on the Ridge, and the army was thus, in a sanitary point of view, fairly circumstanced.

The most rigorous attention to every detail of sanitation must be paid. It is now especially imperative that every one should, by some makeshift, sleep off the ground, that the space should be drained, and that the water supply should be kept pure. If the rains are on, collect all the rain-water by waterproof sheets, tubs, or any contrivances. If water be at hand, arrange especially to let every man bathe regularly every day, and thus to keep his body clean, for the possibility of typhus must be kept in view, although I doubt if it ought ever again to arise, now that the rules for its prevention are so defined.

The water supply should be defended as much as military resources will allow. For a short allowance of water is especially to be feared. Let wells be dug, and the water, if obtained, filtered.

Fort Lydenberg.

At the siege of Fort Lydenberg, in Natal (January 6 to March 31, 1881), the troops felt chiefly the effects of water privation. Their preserved rations also being conducive to thirst, the men feared to eat them. A small bottle of beer was issued to each man, but seemed rather to increase his thirst. Added to this the ration was reduced to ½ lb. preserved meat, 1 oz. sugar, and 1½ lb. of meal. Nevertheless, our men managed to pull through. The effects of want of conservancy were seen, resulting from the non-removal of the latrine tubs. Owing to the heavy fire these

could not, for the first two days, be removed; three men posted near them were seized with "continued fever," one case proving fatal. The tubs were removed after the second day, and no more cases occurred.

At Potchefstroom, in the same war, 305 people were shut up in a fort 25 yards square, without cover, and were under fire day and night, with scanty supplies, and a limited amount of water, yet the general health remained "marvellously good." The siege lasted from December 18 to March 23. Not only, however, was the most unremitting attention paid to sanitation, but the men, "being without cover," were, at any rate, well ventilated. Thus both the adverse factors of camps, in the soil and air, were not allowed to come into play, and hence the good health. Potchefstroom.

Lime-juice should be on no account omitted on these occasions, whilst the cocoa or coffee rations should be served out both morning and evening.

During the late Afghan war our troops were besieged on two occasions. The investment of Cabul occurred, it is true, in the winter, when the tropical heats of summer had given way to the severest frost; yet this siege may be mentioned in a work on tropical campaigns, since it furnishes a conspicuous example of ideal arrangements under such circumstances. I cannot speak from experience, as I had left the camp by the convoy just previously bound for India. But the main facts are well known. Though kept within the walls, and thus harassed by fatigue from continual duty, no other adverse factors were allowed to enter. The space defended was so large that no overcrowding occurred. Above all was the good *morale* of the troops. Again, since the battle of Charasia, and the capture of Sherpore, a large stock of provisions had been laid in. Hence there was no reduced ration. By order of General Roberts, tinned soups and cocoa were served out night and morning to all European soldiers; additional comforts were given also to the native soldiers; the water supply was looked after, and the men on sentry were protected from the weather as far as possible. Afghan war. Cabul.

With regard to the siege of Candahar, the characteristics of the siege of the Sherpore cantonment at Cabul do not appear to have been so prominently conspicuous. Candahar.

CHAPTER XIV.

PROPHYLACTIC "RATION" AND INOCULATION. PARADES OF INSPECTION.

"Rations." IN the various chapters on the special diseases will be found the line of treatment by special prophylaxis. I need here only mention lime-juice for scurvy, arsenious acid for malaria, dilute hydrochloric or sulphuric acid for cholera, bismuth for dysentery. The value of these remedies will be fully shown.

Vaccination. The question also of "vaccination" and its results will be entered into with reference to specific infectious pneumonic fever, small-pox, and yellow fever. No reference has been made to Ferran's experiments in cholera, as his inoculated material evidently is not restricted to the specific bacillus. And, moreover, the evidence is so contradictory that no line of treatment has been as yet established on this basis.

Parades. Lastly, it will be evident that regular "parades" for the detection of the early symptoms, if present, of camp diseases must form one of the most efficient means of keeping the army in health. The diseases in which they are especially indicated will be found in the succeeding portion of this work. It is important also to remember that similar parades be held at odd times to see that the men are wearing their cholera belts.

PART II.

SPECIAL DISEASES.

CHAPTER I.

BOWEL COMPLAINTS.

THE affections included under the term "bowel complaints" demand our attention with greater importunity in tropical campaigns than those of any other class. For, however healthy in other respects a campaign may be, we shall always meet with "bowel complaints." For instance, in the Red River expedition, conducted in a cold climate and one totally different from that of the tropics, diarrhœa and dysentery at times prevailed. Again, in the fourteen campaigns of the following wars, first Burmese, China, New Zealand, Abyssinia, Looshai, Ashanti, Duffla, Malay, Afghanistan, Egypt (1881), Aka, Zhob Valley, Nile, Eastern Soudan, we find bowel complaints to have headed the list in ten—viz., in Burmah, China, New Zealand, Abyssinia, Looshai, Duffla, Malay, Egypt, Nile, and Soudan. In fact, the experience of all army surgeons has ever been in this direction.

First Burmese war, 1824–6.

In Campaigns.—The following review will illustrate this at once. In the first Burmese war, 1824–6, Sir Ranald Martin draws especial attention to the fact that of the diseases which destroyed the European portion of the expeditionary force in Ava, dysentery—scorbutic dysentery—was by far the most fatal and prevalent disease. In China (1860) bowel complaints again headed the list, causing 3374 admissions among the European troops, and 1130 amongst the natives, out of a force of 20,438; and a European mortality of 3.14 per cent., with a native mortality of 4.42 per cent.

China, 1860.

New Zealand, 1863–5.

In the New Zealand war, 1863–5, practically a semi-tropical campaign, "bowel complaints," with typhoid fever, formed the prevailing diseases.

Abyssinia, 1867.

In Abyssinia, 1867, they formed the highest ratio of admission —27.75 per cent.; whilst they constituted 47 per cent. of the mortality.

Looshai, 1871.

In Looshai, 1871, in the left column, out of a total mortality of 319, of which cholera accounted for 155, the deaths from dysen-

tery were 38, from diarrhœa 63, or a total mortality from bowel complaints of 101. Again, in the right column, with fevers they constituted the prevailing diseases.

Ashanti, 1873. In Ashanti, 1873, they were again prominent.

Duffla, 1874–5. In the Duffla campaign, we find the following percentage on the several admission rates:—

	Amongst Troops.		Amongst Transport Corps.
Dysentery . .	28.79 per cent.	...	33.25 per cent.
Diarrhœa . .	11.43 ,,	...	6.58 ,,
Total . .	40.22 ,,	...	39.83 ,,

Malay, 1875–6. In Malay, 1875–6, they constituted the "scourge of the force." In the Buffs, dysentery caused an admission rate of 70.11 per 1000, with a mortality of 8.34 per cent. Next to dysentery came diarrhœa.

Afghan, 1878–80. In the Afghan war, 1878–80, we find bowel complaints occupying the second place to "fevers." The rate was for the different columns as follows: In 1878, November and December, among the European troops, out of 2059 admissions into hospital in the Khyber column, 72 were for dysentery and 122 for diarrhœa, with 1 death for dysentery; in the Kurram Valley, out of 1066 admissions, 40 were for dysentery, with 2 deaths, and 41 for diarrhœa; in Southern Afghanistan, out of 1214 admissions, 56 were for dysentery with 1 death, and 86 for diarrhœa. In 1879, in the European troops, there were admitted per 1000 of strenth 110.5 cases of dysentery and 194.4 of diarrhœa in the Khyber column, the deaths per 1000 of average strength being 5.54 for dysentery and 1.17 for diarrhœa. In the Kurram Valley, in like manner, admission and deaths for dysentery per 1000 of strength were 55.0 and 3.48 respectively; for diarrhœa 62.3 and .35; in South Afghanistan, for dysentery, admissions and deaths per 1000 were 78.4 and 4.73, for diarrhœa 102.0 and .79; whilst for the troops in Sherpore the corresponding rates per 1000 for dysentery were 19.8 and .38, for diarrhœa 16.0 and .76. Lastly, in 1880, for the European troops in the different columns, the rates per 1000 were, in the Khyber column, 134.3 admission and 10.25 deaths per 1000 for dysentery, 206.4 admissions and 3.76 deaths for diarrhœa; in the Kurram column, 42.3 admissions and .94 deaths for dysentery, with 70.4 admissions and no deaths for diarrhœa; in South Afghanistan, 62.5 admissions, 6.46 deaths from dysentery, with 72.2 admissions and 3.77 deaths for diarrhœa; and in Kabul and its neighbourhood, 20.6 admissions with .25 deaths for dysentery, 57.2 admissions with .25 deaths for diarrhœa. Amongst the Native troops, in like manner, we find the following ratios in the different columns: In 1878 there were 13 deaths from dysentery, and 2 from diarrhœa in the Khyber Valley; 5 deaths from dysentery in the Kurram column, and 6 deaths from diarrhœa in the South Afghanistan column. In 1879, in the Khyber column, admission and deaths per 1000 of strength for dysentery were respectively 292.8 and 11.27; for diarrhœa, 261.4 and 8.18; in the

Kurram for dysentery, 235.5 and 8.98, for diarrhœa, 101.1 and 7.66; in South Afghanistan 188.2 and 11.26 for dysentery, 193.5 and 5.28 for diarrhœa; and in Sherpore 43.0 and .81 for dysentery, with 76.7 and 1.22 for diarrhœa. Finally, for 1880, we find in the Khyber column per 1000 of strength, 319.9 admissions with 10.58 deaths for dysentery, and 233.4 admissions with 8.99 deaths for diarrhœa; in the Kurram Valley, 126.8 admissions with 6.18 deaths from dysentery, and 80.8 admissions and 4.28 deaths from diarrhœa; in South Afghanistan, 190.8 admissions with 3.19 deaths from dysentery, and 162.0 admissions and .80 deaths from diarrhœa; in Sherpore and its neighbourhood 28.6 admissions .89 deaths for dysentery, with 72.7 admissions .59 deaths for diarrhœa.

In Egypt in 1881 bowel complaints again constituted the largest admission rate—viz., 191.5 per thousand. In Aka (1883–4) they occupied the second place to ague. In the Zhob Valley (1884) the principal admissions were for ague and bowel complaints. In the Nile expedition (March 1884 to July 1885), out of a strength of 10,771 non-commissioned officers and men, diseases of the digestive system caused an admission rate of 2402 or 223 per 1000, with a death-rate of 72 or 6.8 per 1000. Of these 2402 admissions, diarrhœa and dysentery accounted for 1834, whilst 60 of the deaths were due to dysentery. Again, the Suakim expeditionary force of 1885, diseases of the digested system headed the list a long way in front of those of any other class, amounting to 95.6 per 1000.

Egypt, 1881. Aka, 1883–4. Zhob Valley, 1884. Nile expedition, 1884–5. Suakim, 1885.

The same experience is found in the armies of other nations even in temperate climates. Virchow has shown how suddenly the rate goes up when peace gives way to war. Thus, in the German army in 1868, there were 327 cases of dysentery; in 1869, only 65; but in 1870 there were 2000. Dysentery constituted one-sixth of the whole admissions.

German army.

In Egypt, Napoleon lost 2468 men from dysentery. In Algiers, the French as a rule are healthy in barracks, but directly the army takes the field bowel complaints—*e.g.*, dysentery—become rife. Desgenettes states that a greater number of men died from dysentery between 1792 and 1815 in the French army than fell in the great battles of the Empire. Again, in the French expedition to Mexico, dysentery was very common in the force.

Napoleon. Algiers. French army.

Notwithstanding the great influence of bowel complaints in all wars up to the present time, we maintain that this marked prevalence should be diminished in the future. Even now we notice no longer the fearful epidemic character of dysentery as it occurred in the armies of the Napoleonic era. One can well imagine how the crowded state of the camps, the monotonous and indigestible diet, the exposure, and unsuitable clothing must have influenced the epidemicity of the disease in the pre-sanitary age. Now all these defects are more or less rectified, but there is yet room for progress in this direction.

Nature of Bowel Complaints.—In this chapter I shall make

no distinction of the pathological difference of diarrhœa and dysentery, beyond some special remarks on the true epidemic dysentery and scorbutic dysentery. The etiological factors of "bowel complaints" will be more insisted on than the etiology of dysentery and the etiology of diarrhœa. I do not mean to imply that the ordinary diarrhœa is the same as dysentery, but by grouping them together as bowel complaints we shall get an insight into the prevention of both. True epidemic dysentery, or diphtheria of the intestines, is a disease *per se*, still the causes predisposing to the ordinary form of dysentery included under "bowel complaints," as now generally met with, will also predispose to this true spreading epidemic, now happily a disease of the past, we hope. As a rule, bowel complaints begin as diarrhœa, then a few cases of dysenteric diarrhœa come in, or an aggravation of the diarrhœa both in severity and in anatomical extension to the lower segments of the bowel. But they may also begin as true dysentery, or that disease which will constitute true epidemic dysentery, if by reason of camp foulness and insanitation it gets beyond bounds. All these clinical varieties correspond indeed to post-mortem changes in "bowel complaints"—viz., simple intestinal catarrh; follicular enteritis, simple and diphtheritic; intestinal diphtheritis. Thus, we see under bowel complaints we have a gradually ascending scale of conditions corresponding to anatomical changes, and in many cases merging into one another. In clinical language, "dysentery" may include catarrhal inflammation (catarrhal dysentery); follicular ulceration (follicular dysentery); diphtheritis of intestines (true dysentery). What I would insist on, therefore, is to hold the view that dysentery will arise in campaigns from causes persisting; by a timely removal, the "bowel complaints" may not go further than the stage of diarrhœa. And it is the more important to bear in mind this persistence as a factor, as, during the aggravation of the process, an infective power becomes developed. Although as yet the relation of micrococci to true sporadic and epidemic dysentery has not been fully worked out, yet all analogy tends to prove such exist, whilst Prior has actually described and figured them. In the aggravation of the lesion causing the primary diarrhœa, we may suppose the soil and environment rendered fitting for the "contagion," and thus infected powers will be acquired. Be this, however, as it may, the probability of a gradually acquired infection is to be steadily held in view.

I do not indeed think that the primary fatal spreading dysentery of armies of the pre-sanitary age will ever again attack our army, provided the sanitary measures taught by experience are to the fore. The words of Virchow regarding plague may be aptly applied to the dysentery of past ages. "The plague is now almost a disease of the past. Although a short time ago the news of fresh outbreaks of this sickness on the Euphrates disturbed our minds, we have the consolation of knowing that with the introduction of planned social regulations in their own native land, the danger threatening epidemics have come to a standstill."

As to the gradually developed infection of dysentery engrafted on diarrhœa, I cannot illustrate the process better than by quoting Heubner. The infection lies in the stools, as in cholera and enteric. But the power of infection is only gradually acquired. "It would seem that there is a limited contagion by means of the excreta of dysentery, which, however, only becomes active when a large mass of excreta is collected together. It is not impossible that small quantities of the miasmatic poison are discharged in the stools of the patients, and, when collected together in sufficient quantity, can poison the subject." We have here two most important prophylactic measures indicated—viz., (1) segregation and (2) disinfection. The doctrine that bowel complaints can assume an infective character, especially when many patients are accumulated together in a confined camp, is never to be lost sight of. Infection of dysentery.

Besides this acquired infection developed from primary diarrhœa, infection also is undoubted in primary dysentery. To quote from civil life, Roth, citing Mongeot, gives the following striking instance:—"A patient suffering from dysentery came to the Hôtel Dieu from Madagascar. At the time of his admission there were no cases of dysentery in hospital. The man went out uncured. After eight days from his admission, cases broke out in the Hôtel Dieu. The man from the hospital went to an inn; the waiter thereof was shortly after seized with the disease. After leaving the inn, the man went to a village in Aube; in this village, again, cases broke out after his arrival. Finally, he went to a family at Brienne, and of that family several members were then seized with dysentery." Trousseau, again, calls attention to the infectious nature of the disease, as seen in the army in Algiers. Infection of attendants and physicians has often been recorded. A final instance of infection may be given. The French ship *Aigle*, when cruising off the West Coast of Africa, was seized with dysentery. Another ship, the *Loiret*, was her consort, but remained perfectly free from the disease until she took in part of the crew of the *Aigle*. Then dysentery broke out in her also. These instances give us indications that special precautions must be observed in camp, and in particular by those in contact with the sick.

I will now indicate the chief prophylactic measures analytically:—

Selection of Troops.—Bowel affections especially attack new comers into the tropics. This is, no doubt, greatly due to the relaxing effect of the heat on the system. Bryden, Laveran, and numerous writers, all attest to this fact. Laveran shows how men having only one year's service in Algeria were five times more affected with dysentery and diarrhœa than men over one year's service. Bryden shows how the admissions in the third year of service in India were one-half of those of the first year. He also especially shows how the rate increases enormously if such newly arrived regiments take the field. Thus, taking the standard admission-rate, 1860–69, for dysentery to be 48.9, and for diarrhœa

109.4, the new army in the field in 1858 gave similar admission respectively, as 231.7 for dysentery, and 303.5 for diarrhœa. With regard to this army of 1858, he traces its history on to 1863 as follows :—

	Admission per 1000 of Strength for Dysentery.	
	Admitted.	Died.
1858	202.6	27.14
1859	118.7	10.20
1860	75.2	4.68
1861	65.5	3.67
1862	48.8	2.66
1863	47.0	2.48

Avoid (1) new comers.

Hence we should here leave behind all unseasoned soldiers such as men in their first years of service. Roth has drawn attention to the liability of young soldiers, even in temperate climates; in Strasburg, for instance, in a certain year, 61 per cent. of the cases of dysentery were amongst soldiers in their first year of service.

(2) Old sufferers.

Again, all sufferers previously from bowel complaints should be weeded out of a regiment when proceeding on service. During the China war, at Talien-whan, diarrhœa, running into dysentery, became prevalent; it was found that the admissions and mortality occurred chiefly amongst the men who had had these illnesses previously in India and Hongkong.

(3) Men with bad medical history.

Thirdly, the previous health of the regiment has an important effect. In the Duffla campaign the 16th N.I. came up from Assam to take part in the operations, having been very unhealthy there. Now, look at the percentage of admissions for bowel complaints to average daily strength of the four regiments of the force—

42nd Assam L.I.	19.60 per cent.
43rd ,, ...	8.82 ,,
44th ,, ...	9.60 ,,
16th N.I.	40.39 ,,

(4) Men with previous malaria.

Fourthly, men with a strong history of previous malaria should be left behind. Maclean and Sir Ranald Martin draw special attention to the influence of malaria in predisposing to diarrhœa and dysentery.

(5) Choose men naturally suited to the climate.

Lastly, as regards native troops, choose those regiments whose native country is similar in climate to that of the intended seat of operations. Men recruited up-country in India are especially liable to bowel complaints when they are transferred to low marshy countries or districts abounding in jungle. Doubtless, the results in the 16th N.I. just mentioned were partly due to this factor. The men of the Assam regiments would find in the Duffla country a more congenial climate than the men of the 16th N.I., who are not recruited from these parts. And as regards Europeans and natives, the difference is speedily visible. The Malay war, for instance, showed a far less mortality from bowel complaints amongst the native than amongst the European regiments.

Selection of Period for Operations.—Diarrhœal and dysen-

teric affections are certainly connected with temperature. Of 546 epidemics collected by Hirsch, fourteen-fifteenths began in the summer months. In Algiers, according to Catteloupe, of 5496 cases, 2471 occurred in July, August and September. "In the tropics it is best to avoid entirely those regions where dysentery is endemic, in the dangerous season of the year. Especially is this important as regards armies" (Heubner).

Avoid hot and rainy seasons.

Besides the hot, the rainy season is especially dangerous. The ground and air, being then moist, predispose to these affections. Annesley relates how dysentery rages in Bengal in the rainy season; Pruner how it is rife in Lower Egypt at the time of the overflow of the Nile. This effect of rains is greatly due to their washing decayed animal and vegetable matter from the surface of the ground into the streams, thus rendering the drinking-water impure. Hence, as far as possible, we should avoid these seasons. Again, it is not so much the hot weather as the alternation of hot days with cold nights, that is a fertile source of bowel complaints.

Influence of temperature.

In the Abyssinian war the bowel complaints were in a great measure due to the rapid alternations of temperature; in Algiers, again, they are rife, owing to the great difference between the day and night temperature. In the Soudan was found a diurnal range of temperature amounting frequently to 40°; a scorching sun, bathing the body by day in a profuse perspiration, was succeeded by a sharp breeze at sundown, stopping the perspiration. This, at night, was followed by a cold, cutting wind. In consequence, bowel complaints were rife. In the China war the same sequence occurred—even when the general health was good, bowel complaints were present due to the atmospheric vicissitudes. Thus, after the capture of the Taku forts, in August, diarrhœa, running into dysentery, prevailed. Now, at this time, great alternation between the day and night temperatures came on. The temperature in the sun in the middle of the day would be 142°, at night 49°; or, in a tent, 98° in the day and 49° at night. Bowel complaints continued, up to October, to form the chief part of the small cases of sickness, and here be it noticed that the medical historian distinctly dwells *on the clothing of our men not being adequate to resist the changes of temperature.*

In Ashanti, in 1863–4, the same sequence was noticed—the days were very hot and the nights very cool.

In Looshai, bowel complaints arose chiefly owing, it was thought, to the sun exposure by day and lowered temperature at night. Further examples, again, are offered by the medical histories of the Umbeyla and Galeaka-Gaika campaigns.

Finally, in the Afghan war, taking the year 1879, we find the cases distributed by months as follows:—

European Troops.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Dysentery . .	75	69	48	88	87	83	64	57	54	61	60	42
Diarrhœa . .	88	82	75	131	144	200	124	96	41	59	56	51

Clothing.—We have seen here, as we shall so often in the

future, how important the subject of clothing is. We see how woollen textures, as before insisted on, are pre-eminently necessary as being the textures most capable of keeping up an equable temperature for the body. Cholera belts must be stringently insisted on, and there should be periodical inspections to see that the men are wearing them; they should not be held at regular stated periods, but rather without warning, so that the men may not have time to put on their cholera belts for the purpose of inspection.

Marching.—The main point in regard to marching, is to exercise the greatest care that the men do not get chilled after arrival in camp. Let not the men remove their coats till they are thoroughly cooled. Above all, the men must never be allowed to open their shirts when heated, and expose their bodies. When not on the line of march, this also must not be done, as for instance in the evening, when perhaps a cool breeze springs up; the men then emerging from their tents after the heat of the day, are apt to loosen their shirts, and let the breeze play about the body; but however dangerous this certainly is, it is still more dangerous to do so when heated from exertion. Care must be taken that the marches themselves *be not too long or fatiguing.* Horton cites cases showing how long or fatiguing marches can excite "the most fatal form of dysentery" in men who have been exposed to the predisposing effects of diet and exposure. In 1864, in the Ashanti expedition, a detachment of 200 men had been kept on salt rations for three weeks on arrival at Cape Coast; they were then ordered to Prahsu camp; on the march thither three of the men were seized with the worst form of dysentery, and a fourth on arrival in camp; they could only have been thus seized from the long and fatiguing marches they had taken to reach Prahsu.

Not too long or fatiguing.

The Camp.—In warm countries there is often seen a close connection between bowel complaints (especially dysentery) and malarial fevers: it has been even held by many that malaria is of itself an exciting cause of dysentery. Whether this be the case or not, it is certain that a system undermined by malaria is of itself predisposed to dysentery. Bowel affections also are especially rife in most swampy regions. The following examples serve to illustrate the bad effects of certain localities on bowel affections, and will show what places to avoid if possible:—

1. Camps in proximity to a large river should be avoided. Morning fogs are frequent, and are very dangerous. In the Malay expedition, the site of the camps in the swampy ground near the river had much to do with the prevalence of the "bowel affections" that were so marked a feature in the campaign. Again, the details from Malacca in the Sunjhie-ujong expedition were encamped at Ampanga on very damp ground, and suffered greatly from diarrhœa.

2. Irrigated land is provocative of bowel complaints. At Kassassin, much diarrhœa was brought on by encamping on the irrigated land at this place.

3. Abundant decayed vegetation and dense forests are very unhealthy in this respect. At camp No. 6 in the Duffla expedition, the soil, in addition to being swampy, was covered with decayed vegetation. The forest also was so dense that the sun was only visible for four or five hours. The fogs were cold and penetrating. Now, during the stay at this camp, the general health at once deteriorated, whilst the affections were chiefly "bowel complaints."

4. Old camping grounds are to be especially avoided. These will be impregnated with refuse and excreta of men and animals. Dr. Hendley, in charge of No. 2 Field Hospital for followers with the British forces, Eastern Soudan, 1885, shows how large an admission for bowel complaints occurred amongst the natives of India. encamped on a soil impregnated with the excreta of men and camels.

5. Finally, avoid camping on the field of battle as much as possible. A stay in such a locality must be shortened as far as military reasons will permit.

But bowel complaints will also occur on the healthiest sites, if certain camp rules be not enforced; attention to, and enforcement of, these rules, will go far to compensate for a bad site, whilst this neglect will do away with all the advantages of a good site. Camp rules.

(1) The first of all rules is to change the site of the camp at regular intervals; whilst, should bowel complaints break out, change the camp at once. Morache draws especial attention to the effects produced by not changing camp at regular periods. The presence of a large number of men persistently remaining on one spot must inevitably infect the soil, whatever precautions are taken; organic matters from excreta of men or animals are trampled into the earth; foul water from various sources, such as from the kitchens, &c., is also imbibed by the soil, and soon a veritable forcing-bed for zymotic diseases is formed. And how this process must be advanced under a tropical sun! The infection of the soil, thus arising, is of itself sufficient to start the various forms of bowel complaint, including even epidemic dysentery. As regards temperate climates, the siege of Metz in 1871 showed the good effects of changing camp. Dysentery attacked both the belligerents, but the besiegers suffered less, inasmuch as within certain limits they were able to change the sites of the various camps. In the Zulu war, diarrhœa and dysentery prevailed for a long period at the Lower Tugela and Fort Chelmsford, due to the prolonged stay on the same spot. During the New Zealand war, after the occupation of Waikato in 1864, several Government officials were employed in surveying the district. They constantly changed their camping ground and remained perfectly healthy. After a time, for protection, they were obliged to pitch near the troops, and keep on the same spot. Bowel complaints soon broke out, the more so as their camp was near that of the Land Transport Corps, who had remained encamped on the same spot for some time, and whose camp itself was notoriously unhealthy. As soon as they were able, the survey changed its camp, Change site regularly.

and the bowel complaints at once were arrested. Finally, to show the good effect in at once arresting an outbreak of diarrhœa by changing site, I, on the occasion of a sudden outbreak of diarrhœa in a wing of my regiment situated in the Kurram Valley in the summer of 1879, in which thirty-two men on one day out of the strength of a wing went into hospital, at once ordered the camp to break ground and pitch on a fresh site. The bowel complaints were immediately arrested.

Space to be plentiful.

2. The second rule is to have plenty of space. Avoid crowding the tents as far as possible, and give the most open order possible. At one period of a campaign the camp may have to be contracted for military reasons, but as soon as these military reasons cease, open it out again. For it must be remembered that the most open order of camp gives but a small space per head, and, in addition, we have in camps the more or less proximity of latrines.

Drainage.

3. The greatest attention must be paid to the drainage, so as to ensure no stagnation and putrefaction. Take advantage of natural slopes, and cut regular drains.

Conservancy.

4. The camp must be kept most rigidly clean. All refuse should be burnt. The arrangements generally must be looked after daily by a responsible officer. The treatment of the excreta will be shown presently.

Fatigue duties.

Economize labour.

In connection with the camp, a few indications as regards fatigue duties may be now given. In this respect labour must be economized as much as possible. In the Malay war bowel affections at once commenced when the severe duties of the campaign had begun to tell on the troops, whilst, when the working hours were reduced, the dysentery became less severe. And this brings naturally as its corollary the injunction, that labour should be reduced as much as possible in the sun, for by economizing the hours of labour we can reduce the hours of working in the sun. And this is the more to be observed when the hot days are followed by cool nights. Fatigue predisposes greatly to bowel affections: when the bodily strength is overtaxed, one of the first signs is purging. These points were shown in Malay as follows:—At first the working hours lasted from 6 A.M. to 5 P.M.: bowel complaints attacked both officers and men. Then they were ordered only from 6 A.M. to 8 A.M., and from 4–6 P.M.: a great improvement in health followed; and finally, when working parties only went out between 6–8 A.M., admissions into hospital for bowel complaints almost disappeared. Again, in Algeria, the French infantry suffered much more than the cavalry, having undergone far greater fatigue.

Reduce labour in the sun.

Danger of working in water.

Fatigue duties are especially dangerous when the men are working in water. In the Duffla expedition an outbreak of dysentery occurred amongst the men of the 42nd Assam L.I., but it chiefly affected those who were engaged in making a floating bridge over the river. The water was deep, and the men worked in it up to their waists. The consequent chilling of the abdomen resulted in diarrhœa and dysentery. Cambay draws attention also to attacks of dysentery occurring in the French

army in Algeria amongst men who, after fording a river, had kept their wet clothes on unchanged.

Fatigue duties in a damp stagnant valley are also to be undertaken with much circumspection. In Looshai the 3rd company of Bengal Sappers and Miners suffered severely from bowel complaints when they were working at a road which was simply a dried-up watercourse at the bottom of a deep valley. Here the vegetation was so luxurious as to exclude the sun overhead; the air stagnant and saturated with moisture; the valley itself was shrouded in mist at night, and for the greater part of the day. Directly the working parties reached a higher range the bowel complaints disappeared. In a damp, stagnant valley.

Food.—First, let us consider the drinking water. Impure water plays a notable part in the causation of bowel complaints. This is more especially the case where the water-supply has become contaminated by excreta, and when the latter are the specific excreta of dysentery, bowel affections will assume an epidemic character. In his eloquent lectures, Prof. Maclean greatly insisted on this fact. The Royal Scots, in the pre-sanitary era, when in barracks at Secunderabad, lost 104 men out of 1098 strength in one year; privies were then in use. After the latter were abolished, and the dry-earth system introduced, the 17th Lancers, who occupied the same barracks, had during three years out of a strength of 576 only a mortality of 37. In the operations of war in Egypt again, much of the bowel affection was due to the foul canal water drank by the men. Again, in the 1863–4 expedition in Ashanti, when the men arrived at Swadroo, "such was the want of water that both officers and men were obliged to use, for drinking and other purposes, water of the most filthy description taken from open swamps. The effect was immediate and fatal in some constitutions, whilst in others it manifested itself after some days." It is here, as elsewhere, to be noted how rapid and widespread is the nature of the bowel affection when caused by contaminated water-supply. But impure water from other sources than animal contamination will bring on bowel affections. In Abyssinia the large number of admissions under this head, and their rapid progress to a fatal termination, was greatly determined by the bad water. In the Malay war, the water containing large quantities of slime set up bowel affections. In China, whilst our men were encamped at Talien-whan Bay, bowel complaints were rife in the first, but absent in the second division. Now the first division was encamped on the right side of the bay, where the water was scanty and muddy, whilst the opposite conditions were present in the water of the left side of the bay, whereon the second division lay camped. In the Ashanti war of 1873, the bowel affections were greatly due to the bad water. Stagnant water in many cases in Zululand set up diarrhœa; so has brackish water in West Africa. In China, again, Dr. Massy thought that drinking large quantities of iced water was a fertile source of bowel complaints. In the Afghan war, icy cold water certainly acted thus in my experience. During

Drinking water. Secunderabad. Egypt, 1881. Ashanti, 1863–4. Abyssinia, 1867. Malay, 1875. China, 1860. Ashanti, 1873. Zulu, 1879. Afghanistan, 1878–80.

the hot weather of 1879, half of my regiment was moved out of the hot Kurram plain to a camp in a mountain gorge that debouched on to the plain, high up in the Safed Koh range. The camp was only one mile and a half off a glacier. Descending from the latter, a pure stream of delicious water ran through the camp down the gorge. Now all the officers, including myself, were seized with severe diarrhœa on first camping here. There was nothing to account for it, except the coldness of the water. As we got accustomed to it, the diarrhœa ceased.

The following striking instance of impure water is quoted for the lesson it teaches. Two French regiments of the line—the 19th and 44th, barracked at Neuilly—during one month (August) the 19th were attacked with severe dysentery, whilst the 44th had only slight diarrhœa. The water was drawn for both regiments from the same source. The men of the 19th, however, took their water as brandy and water, the spirit of which precipitated the organic matter in the vessel, in which it putrefied. The 44th, on the other hand, used their water as tea and coffee; the tannin of which prevented putrefaction. Red wine being substituted for brandy in the 19th, the regiment quickly became free from dysentery.

The foregoing results at once suggest the remedy. Avoid, if possible, all stagnant and pond water, but where there is none other, boil and filter it, and otherwise treat the water as I have already laid down. All water, however healthy it may seem, should be thus treated. Especially, warn men against drinking stagnant and slimy waters, where other and better is procurable. Again, let the men be advised to drink their water in the form of tea or coffee or chocolate as far as possible, especially the two former. In these days, when jams are carried to the front, surely red wines could be also supplied. Red wines would be far better for health than jams, and equally good as anti-scorbutics. The soldier is supposed to be in a state of training, and in civil life a man does not usually train on jam. Should the men get tired of tea, a most sustaining drink can be made by boiling oatmeal in water—2 oz. of oatmeal to the quart of water makes a pleasant beverage, and we get the benefit of the boiling. As regards spirits, we see here one of the many reasons against such a ration, in its non-preventive qualities as regards bowel complaints. Again, on the line of march, let the men's water-bottles be filled with tea; it is on the line of march always that many predisposing causes for bowel complaints come into play; the thirsty soldier eagerly drinks any water that is handy, and may thus imbibe poisonous fluid. Care should, therefore, be taken also that the regimental bheesties' mussacks be kept scrupulously clean, and that a proper source be pointed out to them, wherewith to fill them for the necessities of the march.

Finally, in camp, care must be ever taken to prevent fæcal or other contamination of the supply. Laveran tells us how, in an expedition in Algeria, the men were seized with dysentery after drinking contaminated water. The latter had been fouled by

the carcasses of sheep thrown in above the drinking site. All washing must be done below the source of withdrawal for drinking purposes. Bathing parades must also be held below the spot where the drinking water is taken. In the gorge above mentioned in the Kurram, the regiment consisted entirely of Sikhs; they bathed, therefore, every day; a portion of the stream below the camp was marked off for this purpose.

I have not drawn any especial attention to those chemical characters of waters that are said to give rise to bowel complaints, for they can be found in the ordinary books on hygiene. The medical officer must, however, be prepared for them. The water was extremely brackish at certain of the camps in the Pishin Valley, and from its taste contained chlorides: this water caused much diarrhœa in the two camps especially containing it.

Intemperance.

A soldier is occasionally, when on the war path, in a position to obtain intoxicating liquors. After the capture of a city, much excess will follow, unless it be prevented by sentries over the wine-shops and patrols. Intemperance, conjoined with influences producing bowel complaints, causes almost invariably the men to become affected, and moreover, with a severer form of disease. Thus, in China the abuse of "Shamshoo" was a fertile source of bowel affections. Heubaer strongly cautions against intemperance as regards liability to dysentery. The greatest care must therefore be exercised during the days immediately following a victory, to prevent the men drinking the poisonous alcoholic liquors of the bazaars.

Monotonous diet.

The diet should be varied as much as possible. Men get sick of a constant monotonous diet, and moreover, digestion gets out of order, and in a condition predisposing to bowel complaints.

Salt rations.

The salt ration, if in excess, is one of the most, if not the most, predisposing cause for bowel complaints. Long-continued salt rations are absolutely certain to bring on these affections. In the first Burmese war, 1824–6, for six and a half months the troops had salt rations shortly after its commencement, and 48 per cent. perished within ten months, principally of scorbutic dysentery. Here the cattle were in the first place marched to Calcutta from distant stations and slaughtered in February 1824, under a degree of heat so great that decomposition must have set in. It was then salted. Again, in the China war of 1840, notwithstanding this terrible precedent, Government had learnt nothing. Cattle were again marched to Calcutta and slaughtered in the heat of February, with the same consequences to the British troops. The meat was half putrid when the force sailed. In one regiment, the 26th Cameronians, embarking 900 strong and full of health, the result was, that at the end of two months there were not 200 men left fit for duty in the field, owing to the havoc made by scorbutic dysentery. (Martin, Maclean.) But even where the salt ration is not decomposed before salting, we have, as regards its properties, two factors: first, the irritant effect of a salt diet; secondly, the insufficient nutritive power. Again, Dr. Christison has pointed out that the salt ration of military life is always more

highly salted than usual, in order that it may keep for two or three years in any climate. In the West Indies, "in the windward and leeward command, when the rations issued to the troops consisted of salt provisions five days in the week, the mortality from disease of the stomach and bowels among the officers was 2 to 4 per cent., whilst that amongst the soldiers was 20 to 20.7 per cent., or a tenfold ratio. . . . . On the contrary, in Jamaica where salt provisions are issued to the troops only two days in the week, the mortality from the same diseases approximated so nearly in these branches of the service, as to be almost on an equality." Hence, give only salt rations when absolutely necessary. But, on the other hand, an excessive animal diet of fresh meat will bring on dysentery and diarrhœa. M. Cambay draws attention to this fact. After raids in Algeria, the French soldiers have been attacked with these diseases from an excessive diet of fresh mutton procured from the large quantity of captured sheep. Again, tinned provisions will cause diarrhœa and bowel derangement, as was shown towards the end of the Nile expedition. Here, in the men proceeding down the river, a too free indulgence in tinned provisions brought on bowel complaints. Finally, the grain materials of food must be well cooked. The large amount of diarrrhœa and dyspepsia amongst the native followers in Sir Frederick Roberts' great march from Cabul to Candahar was due chiefly to the fact that, owing to their late arrival in camp, they were too tired to cook their food, but ate uncooked atta and Indian corn. A similar experience was gathered in some of the Ghoorkha regiments.

Well-cooked grain food.

Vegetables.

If preserved and compressed vegetables form much of the vegetable diet, as they generally will, they must always be cooked well with plenty of water, and thoroughly softened, otherwise, as so often has been found, they will prove irritating to the mucous membrane, and set up diarrhœa.

Fruit.

The evidence is conflicting as regards fruit. Trousseau agrees with Zimmerman when he says that "fruits, even when not ripe, cannot cause dysentery." But they most certainly can cause diarrhœa. Horton, moreover, has seen "an indisputable case, in which, after an indulgence in green mango, dysentery was induced within eight hours." I, however, in Afghanistan experience, found fruits to have but a small influence in the causation of bowel affections. The profusion of melons and grapes in the Kurram and Logar Valleys was such that an unlimited supply was available. In my regiment, however, no dysentery or diarrhœa arose, or did they appear to arise from this cause elsewhere. It cannot be said that this arose from the ripeness of the fruit, for the latter was doubtless eaten in all stages of maturity. The fruit, however, should be sound. The men should be cautioned on this point, as unsoundness is far worse than unripeness. Finally, as regards strange fruits, the men should eat only those that the natives themselves consume.

Customary food to be

For the native troops, and for camp followers, it is very desirable that, as far as possible, the food to which they are accustomed

should be given. In the Aka expedition, most of the diarrhœa cases occurred amongst the followers, and was thought to be due to the unusual nature of their ration. In the Looshai campaign, the 22nd P.N.I. for the first six weeks received neither goor nor condiments; indigestion followed by bowel complaints supervened, until, on the recommendation of the principal medical officer, these articles were supplied. In the 27th N.I., also, bowel complaints were induced by an unsuitable diet: the atta supplied was very coarse and irritating. And in concluding these remarks on food in relation to bowel complaints, I would suggest, with reference to the last point—viz., that any diet to which a man is unaccustomed, if it be at all indigestible, is apt to set up bowel complaints—that it would be desirable in times of peace to train our men in this respect. For a few weeks at various intervals in the year give the men a campaigning ration, such as they would perforce receive if engaged in a campaign in the tropics. given as far as possible.

Night Precautions.—Certain precautions are necessary at night, and imperatively called for. Our men must be protected both in their tents and when on guard.

Equally important against bowel complaints, as we shall find it to be against malaria, is the rule never to sleep in immediate contact with the ground. This has been shown over and over again in our Indian frontier expeditions. In the Aka expedition, at first men and officers slept on the ground, and suffered generally from congestion of the abdominal organs and a tendency to dysentery. Afterwards, when the force was halted and raised machans made for sleeping on, these affections disappeared. In the Duffla campaign, the Transport Corps suffered more than the troops (as we shall presently see also from malaria), from not having raised beds above the ground. This is clearly shown by the following return for bowel complaints for the expedition:— Sleeping arrangements.

Corps.	Cases of *Diarrhœa.*	Cases of *Dysentery.*
Artillery	3	10
Sappers and Miners . .	6	17
16th N.I.	34	46
42nd A.L.I. . . .	3	44
43rd " . . .	9	9
44th " . . .	3	20
Transport Corps . .	**83**	**419**

The same sequence of cause and effect was shown in the recent Khartoum expedition. The beds should always be raised, and arrangements made such as will be subsequently pointed out under Malarial Fever. The men must also be especially cautioned against leaving their tents during the night, and going out to cool themselves in the air, opening their shirts, &c. Cummerbunds must always be worn at night. Chills are particularly liable to attack the abdomen when a man leaves his tent to go out into the air, particularly as the nightdress will be more or less open. This source of bowel complaints was very fertile

amongst the French in Algeria. Sudden chills will cause spasm of the abdominal muscles, and congestion of the mucous membrane of the intestines, and may thus light up a catarrhal inflammation.

Finally, the men should especially sleep under cover in regions where the dew is drenching and heavy. In extremely hot dry climates, as we shall see under Sunstroke, the men occasionally had better sleep out, but whenever there is much dew they must be under cover. The preventive effect of sleeping under cover was well shown in the case of the Manchester Regiment during the operations of war in Egypt in 1882. This corps was stationed at Ismailia, under good cover. It thus escaped the drenching dews that the rest of the force, not located here, were exposed to, and suffered scarcely at all from bowel complaints. The men on guard should at 9 P.M. have a hot ration of tea, coffee, or chocolate, with some biscuit, and again about four hours after. At 1 A.M. some warm sustaining drink is especially indicated, as dysentery is very apt to seize men about this hour, when the vital powers are least resistant. Finally, give them the general early morning ration. The sentries also should be protected as much as possible from chill. We need not repeat the necessity of cholera belts. A sentry box should be rigged up.

Night duties.

Other Measures.—Thus far we have alluded to the points regarding selection of material and season, of marching, camping, feeding, clothing, and nocturnal arrangements. But the medical officer in addition must be ever on the watch to detect the early cases, and thus to rectify their cause, before they become diffused. Especially must bowel complaints be looked for when the men are during the campaign suddenly subjected to a change of life. Thus, in China, in 1860, after the disembarkation of the troops, bowel affections suddenly appeared, due in a great measure to the change in the environment from ship to camp life. In order to detect the earliest cases, and to prevent their origin, certain "parades" should be instituted; such are the following:—

(1) Parade for Digestive Derangements.—There should be a regular parade daily to at once discover any digestive derangement, should bowel complaints become frequent. All irregularities of the bowel must be attended to at once, whether of relaxation or constipation. Virchow's observations on the changes caused in the bowel above the site of any stricture are to the point here—"Over the narrowed part where a long persistent packing of fæcal material often takes place, a diphtheritic process very promptly sets in, which in violence of local career is comparable only to the puerperal, the sequel being a total necrosis and complete perforation of the wall of the gut." And, furthermore, diarrhœa as seen in the field is, in the vast majority of cases, at its commencement due to the irritating nature of the ingesta. The indication in both is the same: to remove the irritamentum. And this will be accomplished by the timely "ration" of castor oil. All men should be told to report themselves at once when "feeling out of sorts in the stomach," or have colic or tenesmus,

or have constipation. The factor of constipation should be especially impressed upon the men; the warmth of the tropics seems to diminish peristalsis; at any rate there is often torpor of the bowels, and this torpor of the bowels, as Virchow and Annesley have shown, predisposes to dysentery.

(2) Parade for Cholera Belts. As before indicated, there should be unexpected parades, to see if the men are wearing their cholera belts. Especially let the men be warned never to leave them off at night.

(3) Bathing Parades. Parkes recommends also daily bathing parades, as invigorating the body against vicissitudes of temperature and dysentery. Such parades should not be in the evening after the sun has sank, and must be well below the water supply; they must also not be too prolonged, otherwise the men will get chilled.

(4) "Prophylactic Ration" Parade. This will be alluded to presently.

A medical attendant should always accompany every detached party, in order that the first cases may be at once recognized and treated. The wisdom of this was shown in the detached parties of the Red River expedition: how much more is it necessary in a tropical campaign? Detached parties.

Conservancy.—As regards the trenches, the site must be constantly changed; they must not be dug too close to one another. Both sporadic and epidemic dysentery have been held to arise from too long use of the same trench. It would also be advisable for all patients with bowel complaints to have special trenches, as the odours of trenches filled with dysenteric stools can cause dysentery (Levy).

All excreta of bowel complaints should be disinfected; and, as we have seen, the best disinfectant is corrosive sublimate, of the strength 1–500. Let the excreta be treated with the disinfectants as laid down under enteric fever or cholera. They may also be burnt. Prof. Du Chaumont recommends petroleum to be carried for the purpose of burning excreta in these and other cases. Dr. Cuningham, late Sanitary Commissioner with the Government of India, it is true, raises a purely theoretical objection to burning, in that he supposes the smoke and heat may carry infective particles into the air, and may propagate the disease, but in practice this objection may be disregarded. The battlefield must likewise be disinfected as previously laid down. Fournier and Vaidy narrate many instances of dysentery lighted up by inhaling the foul air of a battlefield covered with dead bodies. Disinfection of excreta. Disinfection of the battle-field.

Hospital Measures.—The cases of bowel complaints should not be heaped together, for by concentration they may take on a dysenteric character, and by degrees infection may arise.

The hospital attendants should not eat and drink in the same room as their patients lie.

Roth opines that dysentery is never spread by the bedding or clothes of the patient. With all due respect to the great opinion of Dr. Roth, I would urge, on the contrary, that the greatest care Bedding.

should be employed in the disinfection of clothing and bedding. The method to be employed has already been considered in the chapter on Disinfectants. Typhoid fever and cholera have undoubtedly been spread thus, and so may, and probably has, the analogous disease, dysentery.

The three chief measures, finally, as regards hospital precautions are—

First—Segregation of patients.
Secondly—Disinfection of clothes and bedding.
Thirdly—Disinfection of excreta.

Prophylactic Rations.—Various drugs have been proposed to be taken, similarly as in the case of malaria.

Quinine. In China, in 1860, quinine was given during the season when bowel complaints were most expected, with a view of combating any malarious origin. In Malay it was given for the same purpose, with the view of acting by improving the general health.

Sulphuric acid. Again, a daily ration of sulphuric acid has been recommended in epidemic dysentery with the view of destroying any bacterium that may be the exciting cause.

Bismuth. In the late Tonquin expedition, bismuth was given with this view in the French army.

Of these preventives, quinine would of course be of much value in very malarial regions. Bismuth has the objection that its continued use would probably promote constipation, and thus bring on the very condition predisposing to bowel complaints. On the whole, sulphuric acid has most to recommend it. Moreover, it would act also as a prophylactic to a certain extent to cholera.

Examples of Bowel Affections.—Having now dealt with bowel complaints generally, we will give in conclusion some examples of the influencing circumstances of this class of disease.

In the China war of 1860, at the occupation of Tientsin in September, diarrhœa and dysentery became very prevalent. Why? The troops had been previously confined on board ship, and had then had for a continuous period of time only salt rations and compressed vegetables. On landing and occupying Tientsin, they then drank bad or indifferent water; were subjected to great exposure to the sun in fatigue duties; ate immoderately of fruit, good, bad, and indifferent; drank immoderately of "shamshoo"—a vile spirit. Then, during September, the warm weather suddenly abated, and cold nights came on. A more complete chain of causes for "bowel complaints" can scarcely be imagined. In addition, many of the men had been old sufferers in the tropics.

In the Ashanti expedition of 1863–4, great aggravation of the dysentery returns became evident. The influence of field service was shown strongly; for of the 210 cases in 1864, 163 occurred in the rainy months—April to July—and out of 32 deaths, 26 occurred also in this period. At the camp at Prahsu, rains set in before the camp was finished. The huts leaked. There were vast forests, a river, and dense jungle, composing the site of the camp, which gradually became a swamp. The days were very

hot, the nights very cool, the food indifferent—of salt meat, biscuit, and bad water.

Turn now to the other side of the picture. In the Malay war, dysentery constituted a veritable scourge to the force. In the Buffs, as we have shown, the admission rate was 70.11 per 1000. But two companies of the Buffs remained stationary at Malacca. Here there was no mortality from dysentery, and great immunity from the disease. Why? On account of the light duty, good quarters, no sun exposure, good food, and mid-day heat tempered by a mild sea-breeze. In the rest of the regiment elsewhere, in Malay, the mortality was 8.34 per 1000.

Epidemic Dysentery.—I here make a few remarks on true epidemic dysentery, such as we read of in armies in the pre-sanitary age. There can be very little doubt but that this disease owes its origin to a special bacterium. The special anatomical sign is the diphtheritic membrane. In and upon the mucous membranes, micrococci are found scattered, or aggregated as zooglæa. These micrococci are similar to those found in diphtheria of the fauces. In this disease all the precautions mentioned before must be strenuously observed, and more especially the facts relating to segregation, disinfection, and commencing disorder of the digestive system.

Scorbutic Dysentery.—Scorbutic dysentery forms one of the most terrible phases of dysentery. Nowadays such an occurrence would be a reproach. It is greatly promoted by overcrowding and insufficient food. The prevention is manifest. The laws of diet laid down must be adhered to. Provision for fresh meat and fresh vegetables must be made. In the first Burmese war, the total mortality by wounds and disease came to 727.5 per 1000 of strength. The deaths nearly equalled the number of British soldiers originally employed. Ranald Martin shows also that each individual in this war encountered more risk of life than in three Peninsular campaigns! The chief cause of death from disease was scorbutic dysentery. A severe scorbutic dysentery affected the 21st P.N.I. in the Abyssinian war. Here the native soldiers were only provided with one set of clothes during the campaign. They were, therefore, generally in damp clothes. Owing to lime-juice having been omitted during the voyage, the dysenteric affection became scorbutic, whilst the continual dampness of their clothing was a constant source of general chill, and of abdominal chill in particular. Could any two conditions be more perfect for the production of scorbutic dysentery? We have already drawn attention to the severe epidemic in the first Burmese war, and need only say, in conclusion, that neither the epidemic dysentery of pre-sanitary wars nor scorbutic dysentery should ever again devastate our armies.

CHAPTER II.

MALARIAL FEVERS.

The second great scourge of a campaigning army is comprehended in the class "fevers." Now, this term "fevers" has been used in the loosest fashion. In looking over statistics, we find an enormous entry under Malarial Fevers. There is a tendency to return all fevers as "malarial." In the Nile expedition, March 18, 1884, to July 31, 1885, the truth of the comparative infrequency of malarial fevers was shown. Here the returns of paroxysmal fevers were separated from those for continued. In the regular forces there was an admission rate of only 5.7 per 1000, whilst for continued fevers it was 222.35 per 1000 (A.M.D. Reports for 1884).

Now, on looking over most of the returns of the various tropical and sub-tropical campaigns, it is impossible to gather to what extent malarial fevers have affected the forces, for in very few is there any specific mention of malarial fevers as such at all. According to my experience, malarial fevers do not form a preponderating proportion of the cases of fever admitted into hospital. I have found the majority of cases to consist of simple continued fever, whether in the Punjab, N.W. Provinces, or Affghanistan.

In the following summary of returns of the various campaigns, we cannot, in the majority of them, estimate to what extent malaria has played a part; in a very few we can.

I can, indeed, only show the returns for "fevers" for the most part generally, amongst which malarial fevers represent an unknown quantity.

In the Burmese war, 1825–6, the force operating in Aracan became speedily ineffective from the "malignant fever" of the country. Ranald Martin states that 5500 European and native soldiers were struck down: "Every one who was not dead was in hospital."

China, 1860.

In the China war of 1860, "fevers" occupied the second highest place to "bowel complaints" on the invaliding and mortality lists. Together with bowel complaints and cholera, they accounted for two-thirds of the mortality. There were 1769 admissions for "fevers" for Europeans, 1182 for natives, with a mortality of 2.25 per cent. for the former and .75 per cent. for the latter.

Abyssinia, 1867–8.

In the Abyssinian war of 1867–8, bowel complaints and "fevers" formed nearly half the admissions. "Fevers" gave 19.51 per cent. of admissions, with a mortality less than 10 per cent.

Looshai, 1871–2.

In the Looshai campaign of 1871–2, "fevers," after bowel complaints, again formed the chief disease.

Ashanti 1873.

In the Ashanti war, 1873, "fevers" here constituted the chief cause of sickness. It is noted that the "fevers" were "chiefly remittent."

Duffla, 1874–5.

In the Duffla expedition of 1874–5, "fevers" took the second place to "bowel complaints." The entry here is inscribed as ague. They formed for the troops 27.21 per cent. on the admission rate; for the transport corps 23.01 per cent. and for followers 29.72 per cent.

Sunghie-ujong, 1874–5.

In the Sunjhie-ujong Force in Malay, "fevers" headed the admission list.

Malay, 1875–6.

In the Malay war, "fevers" took the second place to bowel complaints. They were returned for this expedition under the heads of "Continued" and "Malarious."

Afghanistan, 1878–80.

In the war in Affghanistan the first place was again taken by "fevers." The return in the A.M.D. Reports, states the "fevers" were "malarious" in their nature; but according to my experience, the greatest number of cases were of the nature of "simple continued fever," and were not malarious at all.

In the report of the sanitary commissioner with the Government of India the following rates are given for the various columns. For the British troops, November and December 1878, out of 2059 total admissions, and 18 total deaths in the Peshawur column there were respectively 886 admissions with 2 deaths from intermittent fever, and 252 admissions with 1 death, for remittent and continued fever; in the Kurram Valley, out of 1066 admissions and 15 deaths there were, in like manner, 615 admissions and no deaths from intermittent, with 114 admissions and 3 deaths from simple and continued; whilst in South Afghanistan out of 1214 admissions and 11 deaths, there were 434 admissions and no deaths from intermittent, and 138 admissions and 1 death from remittent and continued.

For 1878 no special return for the native army is given. For 1879 amongst the British troops in the Khyber Valley, the deaths from intermittent were 0.58 per 1000 from remittent, and continued 9.91; in the Kurram Valley from intermittent 0.35, from remittent and continued 6.61 per 1000; in South Afghanistan no deaths from intermittent, and 6.30 from remittent and continued; in Kabul 0.76 from remittent and continued per 1000—no deaths from intermittent. In the native troops of the regular army the statistics for enteric, intermittent, remittent and continued as regards mortality per 1000 are all summed up together as 23.63 for the Khyber column, 11.38 for the Kurram, 6.66 for South Afghanistan, and 2.03 for Kabul. In 1880 for the British troops the mortality per 1000 was in the Khyber 0.34 for intermittent, and 8.54 for remittent and continued; in the Kurram Valley 1.88 for intermittent, and 6.57 for continued and remittent; in South Afghanistan 0.54 for intermittent 1 and 3.77 for continued and remittent; and in Kabul 0.25 for intermittent 1.98 for remittent and continued. The statistics for the

native mortality per 1000 are again given under one heading as 20.62 for the Khyber; 26.36 for the Kurram; 6.65 for South Afghanistan; and 5.16 for Kabul.

Zulu, 1879. In the Zulu war, 1879, "fevers" again prevailed to a greater extent than any other class.

Egypt, 1882. In the operations of war in Egypt in 1882, we come upon a better classification than any we have yet experienced.

For the European force—*i.e.*, the force sent out from England—we have the following return given:—For "continued fevers" 73.5 per 1000; "paroxysmal fevers" 17.7 per 1000. Note here what a small proportion the latter bear to the former. And this truth would have been lost had the whole been collected under one head, "fevers." It was, however, reserved for the principal medical officer of the Indian Contingent to be alone in forwarding a true scientific return. This return was as follows, then, for the troops starting from India:—

Ague	123 cases	= 21.67 per 1000
Febricula	28 ,,	
Sunstroke	14 ,,	
Enteric fever . . .	1 ,,	

We have included sunstroke in juxtaposition, as many cases of ardent continued fever run into sunstroke.

Aka, 1883-4. Zhob Valley, 1884. Nile, 1884-5. In the Aka expedition, 1883-4, ague headed the list of admissions. In the Zhob Valley expedition of 1884, "fever" greatly prevailed, as will be seen hereafter. In the Nile expeditionary force, and in the Suakim force, under the heading "Paroxysmal Fevers," we find for the former for the regular forces an admission rate per 1000 of 5.7—mortality nil. In the latter, an admission rate of 5.2 per 1000 with a death-rate of 1.52 per 1000.

Foreign armies. In foreign armies, as regards admission rates, malarial fevers in warm climates play a prominent part. Thus, Dr. Paynter found malarial fevers conspicuous in the French army in Algeria: the same is noticed in the "Third Annual Sanitary Report for Bengal for 1886," with regard to the Algerian army. At any rate, then, it is evident malarial fevers must play an important rôle; and they will also be more rife in a war than in a cantonment; for in a war our tents will probably be pitched on soil that has not been disturbed for years, or not at all; whereas in cantonments the ground will have been drained and prepared; finally, in a cantonment the site will have been selected with a view to sanitation; in a war, all such considerations may have to give way to military necessities.

Etiology.—The nature of malaria must now be gathered. A few words on the theory of chill will suffice. Long ago this view was advocated of the disease; and in recent times it has been brought forward by Oldham and Bellew. Malaria is here referred to weather influences alone, and the marsh theory is directly assailed. Now, as far as the marsh theory is concerned, it has been abundantly proven that malaria is by no means of exclusively palustral

origin. But the theory of chill oversteps itself, like many another dogma. It asserts that there is no specific poison in malaria. This I shall show is entirely erroneous. To get over the fact that marshes cause malarial fever—*e.g.*, in the Terai—Dr. Oldham simply begs the question by declaring that in such places the liability to chill is greater than in non-malarious regions. Prof. Maclean has however annihilated the strained conclusions of this theory, when he showed how in Madras in a certain locality in 1869–70, out of a total population of less than a million and a half, over a million sufferered from malaria—"a terrible consequence to have resulted merely from a chill." He shows, moreover, the real explanation to be, that owing to its geographical position the district was exposed to malarious winds proceeding from the jungles during the north-east monsoon. If this theory of chill were correct, we could easily annihilate malaria by precautions against chill; but in fact the only relation malaria has to chill is that the latter will re-excite an attack in those who have already suffered from malaria. Therefore, leaving Dr. Oldham, let us quote Griesinger—"Without the assumption of a material and specific poison, we shall not proceed far in explaining the endemicity of the fever." Various ideas have been held as to the nature of this specific agent; it has been held to be of a gaseous nature, &c.; but of late all recent investigations tend to prove its parasitic nature. Crudeli has shown that the poison cannot be of a chemical nature, seeing that it remains the same in all malarious places, no matter what the nature of the soil; it must, on the contrary, be a living organism which finds suitable conditions for its existence in every variety of soil. Now, if such be the case, it is at once manifest that we have advanced a great step in the way of prevention, for if we can only find out the conditions of existence of the organism, by destroying these we shall destroy the organism, and with it malaria.

Specific theory.

Relation to soil.

With regard to the relations of the specific organism to soil, the first thing is to discard the idea of its necessary connection with marshy soils. Camps may be pitched on apparently most healthy sites, and still our men may suffer from ague. As Crudeli points out, malaria exists on soils of every conceivable variety, of every age in geological time, and it is impossible to point to any mineralogical or chemical condition which can be said to be essential. Dods, of Florence, has shown that malaria is not necessarily connected with marshes, ponds, rivers, or rank vegetation, but rather in many places with a dry arid soil denuded of vegetation. Townsend, for the Central Provinces, has shown the same. On the shores of the Persian Gulf, again, we have a burnt-up ground, the very opposite of a marsh, there are no rains, no rivers, no vegetation, yet remittent fever is so severe that any one affected with it can scarcely hope for permanent recovery, unless he takes complete change of air away from the Gulf. Crudeli has hypothecated the conditions of existence of the "ferment" to be a certain temperature, a moderate amount of

permanent moisture in the soil, and ready access of oxygen to the strata which contain the "ferment." He shows, moreover, how the ferment can remain latent and inert for centuries, and then again manifest its activity when the soil is stirred up by cultivation or excavation. In like manner the seeds of plants may lie dormant, hence, there is nothing strained in the analogy. And turning to Morache, we find much the same ideas, for he formulates the factors necessary for the production of "malaria" as a certain degree of solar heat, of air, of water, and the presence of organic substances, probably vegetable, in the soil. With these premises it is easy to understand how an apparently healthy soil may be malarious, the ferment may be present in the organic detritus on weather-beaten granite rocks, in the sands of the Landes, or driven deep into the ground. Again, with regard to the burnt-up soil of the Persian Gulf all idea of any humidity seems difficult; but, on the contrary, how humid is the air, and the humid air is contained in the interstices of the soil; the moist heat of the Gulf is notorious. Finally, with regard again to sandy soils, we must remember that deep down below the sandy surface vegetable débris may have been driven by the rain, and there encrusting each mineral particle, at the slightest alternation of the conditions of moisture, the "environment" may become fitting for the activity of the "ferment."

Nature of the malarial organism.

The parasitic nature of malaria satisfactorily explains the peculiarities of the malarious fevers as regards their capriciousness in relation to soil and other conditions better than any other. As long ago as 1849 this view was upheld by Mitchell. I do not purpose, as foreign to this work, to enter into the history of research in this direction, nor indeed to enter into the subject any deeper than will suffice to show the grounds of belief in the malarial organism, and the direction in which such belief gives as indications for treatment. Laveran has described certain bodies existing in the blood of all patients sick of malarial fever; his researches have been confirmed by Kelsch, and by Richard, of Philipville, a district abounding in malaria. The latter has especially pointed out the selected habitat of the organism in the red blood-corpuscle, and described the changes induced. He has also shown how a solution of quinine renders it inert. But the most important, perhaps, of all are the researches of Klebs and Crudeli on the marshes and air of the Roman Campagna and Pontine marshes. Both in the soil and in the air of these malarious localities they discovered constantly an organism—the bacillus malariæ—which they state to be the active agent of malaria. More recently, Marchiafara and Celli have confirmed these researches, and in like manner to Richard, have demonstrated that the parasite directly attacks the red blood-corpuscles of the blood. Indeed, from the several minute descriptions of these various observers, it would seem that the organism described by Laveran as Body No. 2, the organism of Richard and that of Crudeli and Marchiafara are one and the same. Finally, Klebs and Crudeli claim to have produced the disease in rabbits by

Views of Laveran.

Tommasi-Crudeli.

inoculation, but the experiments have been repeated by Sternberg, who, while alleging that only septicæmia was induced, in nowise denies the bacterial origin of malaria.*

We have entered into this purely theoretical subject, as we think the parasitic nature of malaria alone gives us a clue to work on. As Crudeli remarks, the fact essential for the hygienist to grasp is that he has a living ferment to deal with, a ferment which can flourish in soils of the most diverse composition, and without the presence of which, neither marshes, nor pools of putrescent water, are capable of producing malaria. Now, if Crudeli has turned the life-history of the "ferment" to account in enabling labour to be carried on in districts where before such labour was impossible, surely we are bound to take a hint from him in the preventive treatment of malaria as regards our campaigns in tropical climates.

Dr. Cuningham, late sanitary commissioner with the Government of India, has, indeed, stated that "he does not believe the bacillus of Laveran is a bacillus at all." Whilst, however, Dr. Cuningham has not adduced any laboratory research on which he bases this expression of opinion, we have confuting it the exact studies of Richard of Philipville, Marchiafara and Celli of Rome, Osler of Pennsylvania, and Jones of New Orleans, all confirming the parasitic organism of Laveran. We can, holding fast to this idea of the organism of malaria, attempt to baffle its action, either by interfering with the life-conditions formulated as necessary for its existence, or by fortifying the resisting power of our men exposed to it. And here, again, the facts that the red blood-corpuscle is the habitat of the organism, and that the latter tends to produce a necrosis of the blood cells, are of import to us, as we shall see in discussing the prophylactic and fortifying power of arsenious acid.

Three final arguments testifying to the bacterial agency of malaria will now be adduced. Supposing we consider with some that the gaseous emanations from the soil, or a chemical ferment formed in the soil, and raised into the air with the watery vapour were the exciting agents; then, as Crudeli remarks, "the malarious contents of the atmosphere ought to attain their maximum during those hours when the soil is most warmed by the sun's rays, and in which the evaporation of the water it contains, and the chemical processes occurring in it, are at the greatest intensity." Now this is not the case; the shortest experience in the tropics will soon teach that the deadly power of malaria is exerted chiefly in the early morning or after sunset. At these two periods the temperature of the lower strata of the air differs most from that of the soil; hence, ascending currents of air from the soil are then strongest, and these currents bring

* In the American *Journal of Medical Sciences* for April 1885 is a paper by Drs. Councilman and Abbot, of Baltimore, in which, in two cases of malarial coma, small hyaline masses were found in the brain and elsewhere. Arguments are adduced for and against the supposition that they are bodies of the same nature as those described by Laveran and Richard.

the organism with them. Secondly, peaty soils are singular in never being malarious. Now peat contains tar, creasote, tannin, volatile oils, resins, &c. It is a well-known antiseptic dressing. And it is non-malarious, simply because its innate anti-septicism destroys the malarial bacillus. The Highland crofters live in hovels, often with their cattle, in apparently the most unsanitary condition. There are no chimneys, and the smoke from the fire fills the room, yet they are remarkably hardy, and free from tubercular disease. *But* their fires are peat fires, and the smoke is peat smoke, and peat smoke does not afford a fitting "environment" for the tubercle bacillus. Again, the action of quinine on malarial fevers is the same as its action on the parasite. Both cease and become inert. Thirdly, as Osler of Pennsylvania points out, the destruction of the red blood-corpuscles in malaria is as well defined an alteration of tissue brought about by parasitic agency as can be witnessed.

Views of M. Colin.

In concluding this purely theoretical disquisition on soil in relation to malaria, I now mention M. Colin's views, chiefly with a view to emphasize the great fact that arid barren soils are by no means non-malarious. M. Colin views malaria as a power issuing from the soil—*puissance vegetatif du sol*—which is exhausted by cultivated plants. When cultivation is absent, then this power is not exhausted, and malaria becomes a source of disease. He considers that malaria will be most ripe whenever it is not exhausted by plants sufficiently abundant to use it up, and in this sense he speaks of the disease as an "intoxication tellurique."

Malaria as regards Campaigns—Selection of Men.—I now proceed to indicate the various heads of prophylaxis. We must first exercise selection in our material. And here, at the onset, it must be remarked that the specificity of malarial fever differs essentially from the specificity of other fevers due to a specific agent. In malaria, one attack confers no subsequent immunity, on the contrary, it renders the subject more liable to future attacks. Hence, in selecting our men for an expedition, a careful scrutiny into the medical history sheets is necessary.

Previous malarial history.

A malarious taint in a corps or individual predisposes most powerfully to a further development on the campaign. Outside the tropics this lesson is enforced. The soldiers employed at Walcheren never afterwards were serviceable in the Peninsular. They even suffered more than the recruits. But as regards tropical and sub-tropical regions, see what the medical history of the corps

Duffla.

in the Duffla campaign showed us. The 16th N.I. were least able to stand the fatigue. We have seen how they suffered from dysentery. I had arrived in Assam from the unhealthy station of Julpigore. For eleven months previous to the outbreak of hostilities they had suffered much from fever in Assam. The following is the percentage of admissions for the force as regards ague:—16th N.I., 29.06 per cent.; 42nd A.L.I., 3.60 per. cent.; 43rd A.L.I., 7.35 per cent.; 44th A.L.I., 18.40 per cent. Here also we see the 44th Assam L.I. coming next to the 16th, for ague. This regiment also entered on the campaign with a

malarious taint, having seven months before the commencement of the campaign, for the first time in half a century, been transferred from a hill station to the malarious plains of Upper Assam, whilst during the previous rainy season, they had suffered unusual exposure in maintaining the blockade of the Duffla Passes.

The Zhob Valley expedition taught lessons in this direction also. This lasted during October and November of 1884, as far as active operations were concerned. The North Staffordshire Regiment had previously been stationed at Quetta, and suffered much from "fever." In the preliminary march to the base of the expedition, 93 men became knocked up, whilst on the subsequent field service 100 additional men were likewise useless, on the sick list. The 4th P. I., in their long march to Dera Ghazi, were much affected with "fever." During the active operations, 92 men were sent back to the base. The principal medical officer remarks, finally, that the 2nd Grenadiers were the only corps that marched to Zhob in an efficient condition, remaining free from fever throughout the campaign, and with never a lengthy sick list. They had previously been located for some time at a camp elevated above the zone of malarial fever. Even the troops located at the base suffered in those cases where a previous malarial history was present, for example, the Native Artillery and Pioneers. Zhob Valley.

In the Afghan war again, the 14th Sikhs suffered greatly from malaria at the commencement. Previous to embarking on the campaign, they had been for three years stationed in the Peshawur Valley. The sanitary commissioner's report states that it suffered exceptionally whilst in the Peshawur Valley column. Afghanistan.

Again, the Aka expedition of 1883–4 warns us against non-inspection. The coolies from Golaghat, enlisted for service in the Transport Corps, were not medically inspected before the campaign, and fully one-third broke down. They were cachectic and anæmic, and had previously been working in a malarious country. Amongst the fighting men again, the 12th N.I. suffered most from ague; and the regiment had a decided malarious taint. Sir Thomas Crawford has also drawn attention to the bad effect on the efficiency of a corps, where such corps has a previous malarious history. In the war in Afghanistan, the corps affected with malaria before the war, exhibited during the war consistently high rates of sickness following exposure. This was shown both as regards the British and native soldiers, but especially by the latter. Moreover, such previous malaria predisposed apparently to a peculiarly rapid and fatal form of pneumonia following exposure; at least this form of pneumonia affected especially, and more or less exclusively, the men who had a malarious history. Contrast this now with the conditions of a regiment having a clean medical history. I was for some time in medical charge of the 23rd Pioneers, who had come down from Simla for the Afghan campaign in a rude state of health; they had little or no malarious history; the result of the war did not show a healthier regiment Aka.

in the campaign. Apart from malaria weakening the resisting powers of the body against fresh attacks, it has other effects. It is one of the common causes of cardiac dilatation. Hence a regiment is liable to break down from any severe strain. Also in non-malarious localities, the exhaustion consequent on the campaign may of itself re-excite fever, especially if there be also vicissitudes of temperature. On all grounds, a previous malarial history predisposes to inefficiency, and malarial men and corps must be excluded if possible. This also should be so far extended as to avoid recruiting men from malarious districts as far as possible. Dr. Chevers has urged this in the case of British troops.

Age.

As regards age, the young soldiers and recent recruits suffer more than their older comrades (Moore).

Lastly, although we cannot hope to avoid all attacks of malarial fever in a campaign, yet be it remembered that the severer and fatal forms, as a rule, never attack those previously immune from malaria.

Race.

As regards race, the negro presents the greatest immunity. The late Dr. Hilton Fagge states that negroes are proof against ague, but this is not strictly correct. They, are, however, less predisposed to malarial fevers than any other race, and hence would be of the greatest value for field service in the West Indies. In the war of the Secession in America, negro troops suffered least from malaria. The same occurred in Mexico. This comparative immunity amongst negroes is however lost if they remain away from their own country for long, as was well shown in the expedition to the Niger in 1841. Here, out of 158 negroes employed, eleven were seized with malarial fever only, but these eleven had just passed several years in England. Still, the immunity of negroes staying in their own country is not absolute. Out of 15,469 negro troops in Gambia, Sierra Leone and the Gold Coast in 1859–75, there occurred 4983 cases of malarial fever, or 32 per cent. of the native troops suffered (Hirsch). Creoles, however, have no such immunity, during the French war in Mexico, a company of creoles that had been raised rapidly became inefficient from malarial fevers.

Selection of Season.—This is most important. We have already drawn attention to this factor in connection with the feasibility of invading Ashanti Land, and the reasoning thereof of Sir Anthony Home. In the matter of malaria, meteorological influences speak with no uncertain sound. Hirsch's facts show a progressive decrease in extent and intensity from the Equator to the Pole, and there is a certain isobar beyond which it disappears.

Temperature.

Hence, temperature is a principal factor. Annesley states that the severity of malarial fevers is in proportion to the warmth of the climate or season in which they occur. But the highest temperature is not always productive of the greatest amount of malaria: Hirsch says truly that for the tropics in particular it is just at the end of the hot season, when great alternations begin to occur, that malaria is most rife. And this brings us to consider

the bearing of the rains or moisture on the disease. When the rains begin, at the end of the hot season, then indeed is malaria most powerful; the fevers may remit during the height of the rains if complete saturation of the soil have occurred, but only again to increase to this most dangerous extent when they begin to dry up. Such is the general course both in the tropics and sub-tropics. Look at the intense malaria in the Peshawur Valley in September; whilst the most dangerous times for malaria on the borders of the north-west province facing Nepaul is at the drying up of the rains. Moisture.

Hirsch admirably has summed up all these factors into the general effect of seasons. He shows how, with a general consonance of incidence in tropical, sub-tropical, and the hilly districts of tropical and sub-tropical latitudes, malaria yet shows differences both of intensity and of incidence in the three separate subdivisions. Proceeding from the limits of the sub-tropical range to the intensest tropical, we find coincidently we have proceeded from a moderate to the most intense malaria. In the high lying regions of sub-tropics or tropics, the malaria is moderate; it has two maxima, one in spring, one in autumn, and the minimum in the cold weather. Again, in the sub-tropics, such as the north coast of Africa, Persia, Syria, &c., there is but one maximum, beginning in the hot weather, reaching its height at the end of that hot weather, and declining by the cold weather; whilst finally, in the tropics, where, we have the intensest forms of malaria, the disease begins generally with the rains; reaching its maximum when the rains cease and begin to dry up, and attaining its minimum likewise in the cold weather. Thus the season for operating is clearly indicated, whether we consider temperature, rainfall, or the season generally; the hot and rainy seasons are to be avoided, and the cold season selected. And we must recollect also that by operating in the wrong season in the tropics, not only do we incur greater risk of malaria, but we incur also a more intense character of malaria. Few better examples of the fatal results from operating in the wrong season can be found than that of the Ashanti expedition of 1864. Here the troops were campaigning in March, when the rains had become very frequent. On March 31 there were 90 sick in hospital out of an entire force of 360; besides, a large number were constantly going sick, but not admitted, as there was no hospital accommodation for them. By the middle of April arrangements were made for bringing down half the force to the coast. The diseases from which they suffered were "fevers" and bowel complaints. The troops replacing them at this period at once began to suffer from the same; early in June half the entire detachment at Prahsu were sick: on June 18, at length all the troops were ordered down, the force being practically non-efficient from malarial and bowel sickness for any further campaigning. By contrast, look at the medical history of the Ashanti war in 1873 in the same region. Here, again, previous to the arrival of Sir Garnet Wolseley, certain operations had been carried on, and a force

Season. Examples. Ashanti, 1873.

had been camped in the country at an unhealthy season. Malarial sickness, as usual, had come on. The Marines, in particular, became so affected that they had to be sent home, the mortality of the strength disembarked being 17.30. [The "appalling" mortality at Walcheren was less—17.04.] But the continuance of the operations was carried on under Sir Garnet Wolseley from October 2, 1873, to February 28, 1874, the rainy season just setting in at the end of this period. The mortality now for the strength disembarked for the operations was only 3.14 per cent. Here, again, as we have seen, the principal disease was remittent fever.

Duffla, 1874-5.

The Duffla expedition again secured comparative immunity from the choice of season. It was carried out from December to the following February. The chief diseases were bowel complaints and "fevers." But according to the survey officers, who knew the country, the force had a comparative immunity; for after the setting in of the spring rains, the climate of the country explored becomes positively deadly from the increased force of the malaria. Thus, although we can never hope to avoid malaria, yet, by a judicious choice of season, we can at least choose the most healthy season.

Transports.—In the case of European soldiers proceeding from their homes to a tropical campaign, it can scarcely be necessary to do more than draw attention that attacks of malaria have been known to break out in crowded troop-ships at sea. Cases of "ship-malaria" have been narrated, not referable to previous infection of individuals on shore. Here the hygiene of the ship had been bad; dirty bilges, mouldy holds, and ill-ventilated quarters have been present. The prophylaxis is obvious.

Clothing.—The next point is the clothing of our men. This matter has been fully entered into, in the general section of this work. I need only recapitulate the importance of flannel, wool and serge. In India the British troops are better off in this respect than the native. If serge clothing could be distributed to the Worcester regiment during the late Zhob Valley expedition, as a precaution against malaria, why should not our native troops be similarly clad? Khaki drill cotton is emphatically not a good preventive against malaria. During the first part of my career in Afghanistan the men of the Native Mountain Battery, to which I was surgeon, came into hospital frequently with fever. I recommended each to have a woollen jersey. They were procured and worn, with a great diminution from fever. The present khaki cotton drill is totally unfitted for a malarious region, especially for a damp, malarious region. During the Malay war of 1875-6, the cotton drill, from not being frequently washed and dried, became damp and clammy under the humid climate of Perak, and caused much fever, but more especially was it, I believe, a causal factor in the severe dysentery which scourged the force. For jungle warfare especially is woollen clothing imperative.

Again, where there are great alternations of day and night

temperature, as was the case in Abyssinia, flannel especially is indicated for keeping up an equable temperature. We have seen how healthy, compared to the prior expedition of 1864, was the late Ashanti war. Due chiefly to the choice of season, yet the result was, doubtless, aided by the order that serge clothing was invariably to be worn.

The men at sundown should be especially warned never to be without their coats, as this is one of the most dangerous periods. Caution at sundown.

Period for Marching.—The period for marching must next engage our attention. Sanderson, in his "Thirteen Years amongst the Wild Beasts of India," does not favour the early morning. His experience having been gained from an intimate knowledge of the Mysore and Chittagong jungles is certainly of value. The late Dr. Parkes also advised marching in the afternoon in the hot malarious districts; whilst, finally, Morache teaches us also not to set out at the rising or the setting of the sun. Still, I would venture to dispute this dictum, for by avoiding the Scylla of malaria, an army marching in the afternoon will fall into the Charybdis of sunstroke. It will march, in fact, in exactly the hottest part of the day—the radiating power of the earth not having kept pace with the heat given it by the sun, the hottest part of the day, especially in the tropics, is not noon, but afternoon. Indeed, in Ashanti, although it was found that malaria was most powerful in the early morning, yet less harm occurred when marching at those hours than when marching for a length of time in the sun. Moreover, the exposure to the sun itself is likely to excite simple fever, which in a malarious subject will be probably replaced by true malarial fever. Hence, fortify the resisting power by a good meal of coffee and bread, and march the men in the morning. Early meal.

Let the men also smoke in moderation, if the march be through very malarious jungles. Sanderson has found by experience the good effect of tobacco in the early morning in the jungles in warding off the malarious miasma. Smoking.

Arrived at the end of this march, arrangements ought to be made invariably to prevent chill. No sitting in damp clothes is to be permitted. Let the men walk about till the baggage comes up. Let them always, if possible, have their great coats with them; it has been well laid down that a man should never be separated from his great coat. In the Afghan war, after the taking of Ali Musjid, the 14th Sikhs were ordered on to Fort Dakka after the battle without their great-coats. For nearly three weeks they slept on the ground with only their ordinary uniform on. Their great-coats being left behind, malarial fever amongst other affections quickly attacked them in large numbers. The spare shirt and cholera belt could be carried with the coats, and at once changed for the wet one. Whatever be the arrangement, the necessity of preventing chill is important. In systems already charged with malaria, chill comes in; thus, on the Gold Coast, amongst the residents, all of whom are more or less infected with malaria, the paroxysms are excited especially on becoming chilled. Change clothes at end of march.

In the Abyssinian war, as we have already seen, some of the native troops were only granted one set of clothes: the men were often, at the end of the march, excessively chilled from waiting about, and a large amount of fever existed in malarial subjects.

Veils.

With the view of protection from malaria on the early morning marches, it was proposed to issue veils for the men in the Ashanti war of 1873, with the idea of keeping off the malaria from the mouth and nostrils. We believe they were not used. Still, the idea is a good one. It might, at any rate, be utilized at night for the men either on guard or when sleeping. The antiperiodic "ration" finally should be distributed with the early breakfast before marching.

Anti-periodic.

The Camp.—I have already discussed the relation of soil to malaria, and have shown that every soil, nearly, may be malarious. Still, there are certain general rules as regards soil and site which must be laid down. Camps, as we have seen, may be temporary or permanent, and it is needless to say that, for the latter, the greatest circumspection must be shown.

High ground.

As high ground as possible is a golden rule for a camp. Against the vertical uprising of malaria, elevation, however small, affords some protection. Various heights have been enumerated as sufficient to afford protection against malaria, none of which are, probably, without exception. The main point is to have the camp on as high ground as is consistent with military emergencies.

This influence for the good of camping on uplands was well shown during the Zulu war, in the difference in the health, as regards "fevers," of the first and second divisions. The latter division enjoyed a high state of health, being encamped and operating in North Zululand on rolling, bracing uplands. The first division, on the contrary, operated on the coast line—hot, low, and swampy—and suffered much from fever. The locality, also, was aided by the season. The first division remained encamped here during March and June—the malarious months for the region. During these months, indeed, the trader never thinks of remaining in the country, whilst even the natives suffer from "fever." Again, the influence of elevation is shown in the regions of the most intense malaria. On the West Coast of Africa the disease becomes rarer and milder the higher the ground; in the Persian Gulf, the heights surrounding Bassorah are almost free from malaria, whilst Bassorah itself is infected with fever of the worst kind.

Humidity.

Next to elevation, humidity has an important bearing. Damp camping grounds are, as a matter of course, to be avoided if possible; if necessity involves occupation, then measures indicated hereafter must be undertaken.

In the Sunjhie-ujong expedition of 1874–5, ague affected the Malacca detachment encamped on the damp ground of Ampanga. Otherwise the health was good.

Rivers.

Avoid the neighbourhood of rivers when sluggish, as swamps are apt to be found there, especially near the mouth. Should a bar have been formed, the swamp will be still further increased.

The statistics of the American War of Secession show strikingly the influence of rivers in this respect. On the Atlantic coast, all the large rivers, in debouching into the sea, form huge alluvial tracts, whilst, on the Pacific side, a narrow strip of land only separates the sea from the mountains. Now, the sick statistics for 1862 for intermittent fever were: In the force operating in the Atlantic region 195.94 per 1000, in the Pacific region 145.33; and, in 1863, 194.03 for the Atlantic, 121.77 for the Pacific. Avoid, therefore, the embouchures and half-dried beds, with the low jungly ground, along the banks of rivers. The coast line of Zululand near such embouchures was found very malarious. Should, however, military necessity demand it, then remember Sir Ranald Martin's advice, and deepen and clean the bed, incline the banks, and pitch the camp as far away as possible from the banks. In the Persian war of 1857, after the battle of Mohumra, our men bivouacked during the day under the shade of the date groves, moving out at night to the plain beyond to escape the malaria arising from the vegetation and muddy creeks. In the three years 1850–3, a sloop was employed on the West Coast of Africa in the suppression of the slave trade. On the river Congo, where the vessel lay, for seven months, from one to three miles from the shore, it was found that, while those remaining on board rarely suffered, one-third of the crew, ascending the river, and located near the banks, suffered from malarious fever.

The alluvial banks of rivers are not invariably malarious, however. In the China war, in such a camp, to the surprise of the medical staff, there was a total exemption from any outburst of malaria. Even many old Indian sufferers were free. This was held to be due to the impregnation of the alluvium with the marine salt. At any rate, the alluvial banks of the Peiho were not malarious. Certainly marine salt does exercise antagonism to malaria, as shown by the fact that marshes that are regularly overflowed by the sea are not malarious; again, rice fields exposed to the sea air likewise do not give rise to malaria, whereas inland rice fields do (Cornish).

Marshes, as pointed out by Dods, of Florence, are not malarious so long as they are completely covered up with water. In China, the inhabitants living near the covered-up rice fields do not suffer from fever. They are, however, very dangerous when they are drying up. Hence we should form a temporary camp near a completely covered-up marsh. A permanent camp should, of course, never be located here. Again, should military reasons not militate against the proceedings, let fires be lighted around the camp, especially to windward. Such fires will afford protection. Meredith, for instance, cites immunity from malaria amongst the charcoal-burners of Assam; those who live near the pits, breathing the smoky air, are free, whilst their comrades living elsewhere are affected. Sanderson recommends a moving camp in the jungles to be protected by a fire to windward. Again, at the works for the amelioration of the Roman Campagna, the camp of the labourers was illuminated every night by bonfires, Marshes.

"with which they sought to disinfect the air." If we have any neighbouring clump of trees, let such clump intervene between the marsh or rice fields and the camp; it will keep off the malaria.

Even elevated ground is dangerous when related to a swamp. Thus, such elevated ground should be avoided. Avoid the slope of a hill overlooking a marsh, or exposed to the winds blowing across from a swamp. Crudeli seems to doubt that malaria can be caused by currents of air blowing from infected sites in the surrounding country, but the following instance by Dr. Jackson would prove the fact:—Near Kingsbridge, in Jamaica, some two hundred paces from a swamp, a camp was pitched on a dry and elevated site, but exposed to the winds blowing across the swamp. The more elevated part on the right was especially struck by the wind; malarial fever soon broke out there, whilst the lower part on the left remained almost exempt. Those whose tents were pitched on a height in front of the camp, and most exposed to the wind, suffered most, and not one of them escaped infection.

Sites, also, at the foot of hills, which supply a copious downpour of water, are unhealthy, and should be avoided, especially if the vegetation be luxuriant, and the grass greener than that of the surrounding country.

Lastly, the doors of all tents should open away from the malarious quarter, should military necessity demand such proximity.

Ravines.

A few cautions on ravines are necessary. Avoid them, especially where the vegetation is rank. The mouth of a ravine is often dangerous, and the natives will often intuitively plant a grove of trees between their village and the mouth if located thus. The summit, also, of a ravine may be malarious, as at Lundikotal, on the Khyber side, during the late Afghan war. Lundikotal, although 3500 feet high, and with a general sanitary condition perhaps better than that of the neighbouring camps, and with good water, suffered disproportionately from malaria. Now, the rocks of the Khyber Pass leading up to Lundikotal formed a sort of funnel, of which Lundikotal was the summit, and the malaria, passing upwards with the heated air from below, became condensed at the Kotal, and concentrated on the camp.

Brushwood, jungle.

Brushwood and jungle are generally held harmful, and, as a rule, such camping grounds are inadvisable. But in many cases this may not be the case. *Thick* jungle and brushwood are to be avoided; collections of vapour assemble, and malaria abounds in the exhalations; but with *thin* brushwood, if there be free ventilation, so that the air passes readily through it, malaria can be absent.

Recently cleared brushwood and jungle seems always dangerous, especially if the soil be disturbed, for, as we have seen, on Colin's theory, the brushwood serves as a path for eliminating the malaria from the soil; now the brushwood, having been cleared away, the malaria is no longer eliminated, but is ready for action in the soil.

As regards temporary camps, therefore, do not locate them either near dense brushwood, or on ground only recently cleared

from such; avoid all brushwood surmounted with vapours in the evening. Then jungle, &c., with free perflation of air is less harmful, and may be harmless. And with reference to a permanent camp, clear the brushwood away, "fire" the remains of the stumps, disturb the ground as little as possible, and let it be freely ventilated for some time before occupation. The site will then be free from malaria, or, at any rate, as free as circumstances will allow. In connection, however, with this clearing away of undergrowth and brushwood, the Commission lately appointed at Rome to report on "the influence of woods on the Roman Littoral," declared that "the dogma, accepted for the last eighty years, that the clearing, whether total or partial, of tracts of low brushwood, always occasions an increase of malaria, is absolutely without foundation. Those places in which the wood had been destroyed were rather improved as regards malaria."

To conclude, with a crucial example of the bad effect of camping near thick jungle. Dr. Meredith has pointed out how, at the Loajan tea factory in Assam, the labourers' cottages were located in two rows facing each other; one row on the left bank of the Shaan river, with its back towards it, the other facing, with its back towards thick jungle which came close up. The labourers were of the same race, ate the same food, and lived under the same atmospheric conditions, yet malarial fever strongly attacked those living in the cottages near the jungle, and nearly spared altogether those living near the river.

Effect of uprooting the soil.

In making a permanent camp, if the soil be much disturbed, much malarial fever is likely to happen. Every virgin soil should be looked on as a hot-bed of malaria, and precautions taken, such as will be more especially indicated under the question of fortifying the resisting power of the organism.

In the Zulu war, during the erection of Fort Chelmsford, much malarial fever attacked the men engaged on the works, due to the upturning of the soil. At Hongkong so much malarial fever attacked the men of certain barracks that the latter had to be given up. Now, near these especial barracks a great amount of levelling, earth-cutting, and road-making was carried on. The soil was ferruginous clay and disintegrated granite. Dr. Dods, who was called in, caused the nearly levelled ground to be covered with turf, and the scarped sides of the excavated hills to be protected with chunam. In a short time the neighbouring barracks again became healthy.

Precautions indicated in making a permanent camp.

In making a permanent camp we could scarcely, for obvious reasons, cover the ground with turf. We shall rarely, indeed, campaign in the tropics in a turfy country, and the prevention of malaria in the formation of forts and permanent camps on malarious soils is a difficult problem for the sanitary officer of the force. In Italy, Tommasi Crudeli has had great success in reclaiming malarious lands; and his results are a striking instance of the value of thorough scientific theory in pointing out the means to a practical end. Who can venture to scoff at bacterial theories when they have led to such striking benefits? Inasmuch as his researches indicate

the line on which any malarious site can be rendered healthy, let us see how far we can apply them to the permanent camps of war. We must first know the conditions of life of the malarial bacillus; these have been predicated by Crudeli to be (1) A temperature not lower than 20° C.; (2) A moderate degree of permanent humidity in the soil; and (3) the direct action of the oxygen of the air on the strata of the soil which contains the ferment. If any one of these three conditions be wanting, the development of malaria becomes impossible, as the bacillus is no longer able to live. We have thus to work on these three lines—thermic, hydraulic, and atmospheric. Nature suspends herself the action of malaria. Winter causes a thermic amelioration; a warm and dry summer, by exhausting the humidity of the soil, causes an hydraulic amelioration; whilst where alluvial deposits of healthy soil cover up a malarious site from the oxygen of the air, we have an atmospheric amelioration.

Thermic amelioration of malaria in camp.

Now, as regards the attacking of the bacillus on the thermic side, we can do nothing. We cannot control the sun's rays so as to lower the temperature of the soil to less than 20° C. (68° F.). All we can do is to take advantage of the presence of any wooded site for our camp. Thus, the camp on the Peiwar Kotal formed a typical camp, both strategically and medically. Commanding the ascent of the pass, it was well wooded with pine trees, affording a grateful shade to the tents. Still this could not be considered a typical camp in a warm country; in fact, it formed a hill station which happened to command the line of communications.

Hydraulic amelioration.

By acting, however, against the element of moisture, we can do much. The site must be thoroughly drained, the drain should run through the length and breadth of the camp, with due reference to the fall of the ground; they should be deep enough "in all cases to withdraw moisture from any stratum containing decaying vegetable matter." Again, cut drains around each individual tent, such cuttings running into the main one of the camp street. It is astonishing how soon humidity will disappear in the tropics. I have seen the ground of camps under water after heavy storms, yet by the judicious cutting of drains, rendered dry in a few hours, aided by the powerful sun. The importance of systematic draining is supreme. The commission above alluded to in Italy on the influence of woods on malaria, insist that the chief factor was an undrained soil in the causation of the malaria, and that whilst it was a matter of indifference whether the woods be retained or not, nothing but drying the soil by proper drainage would diminish the disease. In Algeria, again, Morache has pointed out how systematic drainage dimishes malarial fever; he instances, in particular, Boufforick, in the Mitidja, formerly so extremely unhealthy from malaria; since, however, the locality has been properly drained, the mortality has fallen to less than two-thirds its former extent.

And it would seem, moreover, that such measures are equally important for the chargers of the cavalry, and for our transport animals as for ourselves. Pettenkofer, at any rate, gives the

following instance, showing how a febrile affection can cause an excessive mortality amongst horses in damp studs. Near Munich were two paddocks, about six miles apart, built on an absolutely identical plan. But the horses in one were perfectly healthy, whilst those in the other suffered an excessive mortality from a low form of fever. Now, it was found out that in the healthy paddock the subsoil water lay at a distance of 6 feet from the surface, whilst in the other, only at a distance of $1\frac{1}{2}$ feet. Drainage rectified the unhealthy paddock, which then remained perfectly healthy.

The fact, however, must not be lost sight of, that hydraulic amelioration must have ever an element of uncertainty in it, because the requisite degree of humidity of the soil, for the development of the malarial agent, may at any time be restored to it by storms. We must, therefore, combine with it, as far as possible, atmospheric amelioration. By atmospheric amelioration we have to exclude, as far as we can, the oxygen of the air from contact with the malarious soil, or else disinfect the air coming from the soil. This can be carried out extensively, of course, in civil life in the way Crudeli has pointed, by "natural top dressings," formed by alluvial deposits, or by felting together the roots of grass. What can we do in camp life? It must be confessed that, unless circumstances are favourable, we can do but little. Still much may be done by well ramming down the soil, taking advantage of healthy alluvium for flooring one's tent. In some of the camps in Afghanistan the floors were covered with pine foliage. The fragrance from the bruized bark and foliage also was an additional protection to the mere mechanical covering of the latter, for the antiseptic odours would surely act on the morbific principle.

Atmospheric amelioration.

A permanent camp, therefore, gradually should be treated on the foregoing principles. The principles being indicated, local ingenuity must supply the means.

To show that this is not all theory, I will, in conclusion, quote the following example of the procedure from Crudeli. In 1883 the grounds of the Janiculan Hill, near the Palazzo Salviati, in the Lungara, notedly malarious, were drained, and densely coated with meadow soil. There has since not been a single case of fever amongst the personnel occupying the Palazzo Salviati, whilst in the Palazzo Corsini, on the same site of the Langara, but looking on the grounds of the Janiculan, which are still exposed to the air and sun, there have within the same period been not a few cases of fever, many of them fatal.

Hutting.

Where wood is at hand we can do much by hutting the men. At the Peiwar the men were hutted. In many of the campaigns on the north-east frontier of India, materials have been at hand for hutting. At Ali Kheyl huts were in many cases made. The process of hutting itself, by affording occupation in monotonous life on the line of communication, will tend to keep off malaria. A good wooden floor, and wooden walls and windows, shutting off the malarious ground exhalations, and excluding the damp

vapours, will do much to ward off fever. Raised platforms also along the sides of the huts can be made for sleeping on, as will be more particularly pointed out further on in this chapter.

In a campaign which is likely to be of some duration, I think that the experiment would be worth trying of providing seeds of various vegetables. Along the permanent camps on the line of communications, plots of ground might be cultivated; this would act beneficially in many ways; it would give occupation to our men; if successful, we should have a certain supply of fresh vegetables, whilst by bringing the ground under cultivation, malaria would be diminished.

Influence of trees.

A few words on the influence of trees may now be added. I have shown that a tope of trees on elevated ground forms an excellent site as regards prevention from malaria. Again, trees act beneficially when they are so placed with regard to any camp as to form a barrier to the transport of malaria from any swamp. In Terracina, for instance, in Italy, an augmentation of fever was experienced after the felling of a cork wood, which had intervened between the affected villages and the source of the malaria. But, on the other hand, where the soil is *damp* and malarious, Crudeli strongly advises to cut down all the trees of the locality; he states that the "cutting down of forests in malarious countries has often proved an excellent means of amelioration; because by removing every obstacle to the direct action of the sun's rays on the soil, its humidity during the warm season is exhausted."

Such, therefore, it would appear is the course to be pursued in the case of the formation of a permanent camp in the immediate neighbourhood of trees growing on swampy ground.

Decaying wood.

Finally, all decaying wood should be removed and burnt. Kellog, of Battle Creek, has drawn attention to the presence of malarial fevers in such sites. In fact, where such decay affects a large area, avoid the site altogether.

Rank vegetation.

All sites with rank vegetation should be avoided for a temporary camp; and in the formation of a camp on the line of communications the vegetation must be treated as brushwood.

Having now passed in review some of the natural features of country favourable and unfavourable for camping as regards malaria, I will conclude this portion of the subject by an illustration from the Ashanti expedition of 1863. Here, as we have before seen, the expedition aborted on account of the excessive sickness from malarial fevers and bowel complaints. There were here two principal camps in the jungle, at Prahsu, and Swadroo.

Example. Ashanti, 1863.

Swadroo.

At Swadroo camp, the men were all picked; the camp was on a slight elevation, and a quarter of a mile from the river; the number of men in camp were comparatively small; the hutting was superior owing to the better facility for hutting; and during the greater part of the time the men had fresh vegetables and fruit. The sickness from malaria and bowel complaints was much less than at Prahsu.

Prahsu.

At Prahsu, all these conditions were removed. The camp abutted on the river; it was surrounded by enormous trees and

jungle; the men were not picked men, and the camp was much larger; no fresh vegetables nor fruit were ever obtainable. As a consequence, the unhealthiness from malaria and bowel complaints was far greater than at Swadroo.

Food.—Having selected and clothed our men, and made the camp as protected against malaria as possible, we next have to consider their food in this respect. As regards the solid constituents of the food, there is nothing very especial to mention. It is self-evident that a full and complete ration should be determined on, in order that the body may be maintained in as robust a state as possible, and therefore so much the more fortified against the poison. The food also should be digestible, as indigestion predisposes to malaria. It has been remarked that whilst a deficiency of albuminates favours the onset of all specific diseases, malarial fevers are especially so favoured. Hence, give a sufficient ration and vary the diet. The importance of a full diet is even greater than that of prophylactic medicine. Livingstone, in his travels in Africa, found that the men of his party who had plenty of wholesome food were safer from fever (malarial) than those who took prophylactic medicine but had not a liberal diet. Surgeon-General Moore also states that the omnivorous Mussulman is less liable to ague than the grain-eating Hindoo. Solid food.

With regard to liquids, the greatest care must be taken with regard to the water. If at all suspicious, it must be treated as already indicated in the chapter on Water. Tea and coffee are supposed to lessen the effects of malaria, and should, if possible, be habitually drank both on the march and in camp. A good instance of drinking tea in a malarious country occurred in the case of Dr. Blanc in connection with the Abyssinian expedition. From Massowah to the high lands, a distance over 319 miles, the drinking-water was bad. Dr. Blanc and Mr. Prideaux always took their water in the form of tea or chocolate, and enjoyed perfect health; Mr. Rassam was less strict, and had "fever"; he then followed Blanc's example and remained free from fever for the rest of the time. The native servants drank all sorts of water, and took very little, if any, care with it: they suffered much from fever and dysentery. It has been asserted, indeed, "that the evidence of the possibility of malarial infection being caused by water, points to an emphatic negative." How far such an assertion is justified by "evidence," is shown by the following experience. Water. Tea, &c.

In the works of the Indian Government to reclaim portions of the Terai, the influence of the drinking-water has been most closely shown. Here the conflict has been deadly between the would-be settlers and the malaria. The water in the streams in the Terai is impregnated with the malarial poison, the drinking of which is not only dangerous but often fatal.

Some few years ago, in October, the most deadly month for malaria in the Terai, some workmen were engaged in repairing a bridge over the Chuka, and were dependent on this stream for their drinking-water. Out of 30 men, only 3 escaped fever, and

several died. Since then a masonry well has been constructed; drinkers from this well do not suffer now from fever.

Again, the villagers of Bahrwa formerly using water from shallow wells fed by surface drainage, repeatedly had to desert their homes from the fatal form of fever prevalent amongst them; a well of masonry, 40 feet deep, was constructed, and the village has become one of the healthiest in the neighbourhood. The Forest Department now constructs deep masonry wells at all their stations, and their employés can now remain permanently at stations at which formerly they had to be relieved periodically every fortnight.

Another example of malarious poisoning by water is given by Boudin. A malignant epidemic of malarial fever broke out on board a French man-of-war, bound from Algiers to Marseilles, when at sea; 13 of the crew of 229 died, whilst 98 had to be admitted into hospital on arrival at Marseilles. On inquiry it was shown that at Bona, the port in Algiers whence they had sailed, the ship had taken in several casks of marshy water. Those who drank of this water had fever, whilst not a single case occurred amongst the crew that drank of water procured from other sources.

Now, malarial fever thus induced is apt to assume a very virulent form. All water, therefore, must be filtered and boiled. But as far as the ration will permit, let the men drink water in the form of tea and coffee, as previously mentioned, in a malarious country. Water from streams flowing down from dense forests, or overhung during their course by trees and bushes, is to be viewed with suspicion in this respect, whilst water from streams bordered by sands or boulders is generally harmless. Other means of avoiding surface water—Norton's tubes, &c.—have been previously alluded to.

Stimulants.

"It has been demonstrated that intermittent fevers, especially in their pernicious forms, are both more frequent and more rapidly fatal among those who take alcohol than amongst those who on principle avoid absolutely all alcoholic drinks" (Morache). We have already seen with what good effects the spirit ration has been abolished. It was designedly omitted in the campaign in the malarious Ashanti country (1873). Gore has pointed out the pernicious effects of intemperance on malaria at Sierra Leone. Desgenettes, in his medical history of the French army in Egypt, Sir Ranald Martin and Sir J. M'Grigor all insist on the same point. Hence, avoid all stimulants.

Smoking.

Tobacco is often a powerful adjuvant in keeping off malaria. Such is the testimony of those ardent sportsmen who seek the jungles in the hot season. In opposition, Sir R. Martin held that it had no such practical effect. But I hold that in the damp tropical jungle, streaming with exhalations, tobacco is an agent for good, for the unadulterated malarious air is, at any rate, not inhaled. Tobacco should not be smoked, however, to excess, for in that case it will predispose to malaria.

Night Precautions.—On the setting of the sun and the

approach of night, malaria becomes again more aggressive. The men will be partly at rest, partly on guard, and in both cases must be protected. For those about to rest, the golden rule is never to lie in immediate contact with the ground. In invading a strange country we can often obtain hints for sanitation even from the unsanitary savage. Hauscka urges the wise sanitarian and campaigner to copy the modes of life of the inhabitants of unhealthy districts. We can, at any rate, take indications from some of them. Travellers and sportsmen in the dense jungles of India have seen that, as a rule, the natives of the jungle never sleep on the ground. For instance, the Tharus of the Terai live in houses built on poles 6–8 feet high, and are supposed to be exempt from malarious fevers. The Bogshas have their floors raised considerably above the general ground level. In the Garrow and Chittagong hills in the north-east of Bengal, the jungle tribes live in houses raised 10 feet from above the ground, supported by means of bamboo posts. These latter races also are practically free from malaria in comparison to tribes who do not take these precautions. The Kurrahoos and Sholagas of Mysore, for instance, build their dwellings flush with the ground; but their physique is miserable, and they are victims to malaria. In the malarial districts of Italy the inhabitants were wont to select sleeping-places on the top of the old sepulchral monuments. In the malarious districts of Greece, and in the Pontine marshes of Italy, the people, during the malarial season, bivouac at night on platforms propped on poles 5 or 6 metres high, and so escape attack. The American Indians sling their hammocks on the highest trees they can find when passing the night in malarious districts; whilst the engineers of the Panama Canal built shanties for their workmen in trees, and so preserved them from nocturnal malaria. The Looshais were found by our people to build their houses raised on strong timber frame-work several feet above the ground. In the valleys, if they have to pass the night, even in the healthy season, they invariably make a machan in a tree, and avoid sleeping on the ground. In Malay, Mattang was built in a mango swamp. The houses of the village were raised on poles 6 feet high, the mud being excavated from the vicinity and heaped up on the site of the future house. The resulting excavations, though becoming filled with stagnant water, until a high tide carried the latter away, did not cause malarial fever to the inhabitants living in these raised dwellings. The Chinese raise their bed-places 3–4 feet high. In Aka country, the huts of all the villages were raised on piles. Many more examples might be cited to show the safety obtained by sleeping high above the ground. I have before alluded to the vertical elevation of malaria; hence it is evident it must be most powerful near the ground.

1. Sleeping arrangements.

The injurious results of sleeping on the ground were clearly shown in the Duffla campaign. Here the Transport Corps suffered far more in health than the rest of the troops. Their work was much harder, and they were deprived of any periodical rests.

Under this pressure of work they neglected their sleeping-places. The dampness of the ground pierced their hastily constructed beds of leaves, and malarious fevers and bowel complaints resulted disproportionately.

Never, therefore, let the men sleep on the bare ground: at least each man in a temporary camp has his great-coat and waterproof sheet, or ought to have them. Straw may be obtainable or dried grass. Ashanti hammocks could surely be furnished per man where the campaign is known to lie in a very malarious country. For the men located in a more permanent camp on the line of communications, arrangements can with greater facility be made. In regions where the bamboo is plentiful, along the sides of any huts formed for the men, raised bunks can be made, or floors of rammed clay can be raised 1 foot from the ground on which the men can lay their waterproofs. Such plans were carried out in Malay and Ashanti respectively. Whilst the huts are being raised, the men could sleep in machans. The bedstead designed and figured by Mr. Longmore in his work on gunshot wounds can be readily extemporized from bamboos or saplings. Tent sacks stuffed with straw can be utilised; palliasses filled with straw as in Zululand; in short, much must depend on the ingenuity of the men and the materials at hand.

The men must, of course, take care not to sleep in damp clothes. The huts and tents must be closed after sunset to shut out the malaria. All who can do so should provide themselves with mosquito curtains. Mr. Sanderson, whose life is constantly in the jungles of Chittagong after elephants, has been remarkably free from malaria, and attributes this to two facts: (1) that he always slept on a bedstead off the ground; and (2) that he always slept within mosquito curtains.

Night duties.

For those on sentry at night, precaution must likewise be afforded. The men on guard should have some coffee or chocolate with biscuit about 9 P.M.; and again strong coffee should be served round about 1 A.M. The men must be warmed and stimulated when most exposed to the malarious air, and no better stimulant is there than the above. Sentry-boxes of bamboo or sacking should be rigged up. Here again also is seen the necessity of good woollen clothing.

Should any camp be in a very malarious district, let the men have an extra antiperiodic "ration" on going on guard. Finally, with the early morning, they will share in the general early morning tea or coffee, &c.

Natural conditions favouring night malaria.

Natural conditions may of themselves aid the increasing force of malaria at night. Thus, on the Gold Coast, where a land wind blows off the shore at night, we find an additional aggravation of the conditions. For, in the interior, thousands of miles from the Gold Coast, the country is covered by dense forests with innumerable marshes and swamps; and without any lofty hills to obstruct the spread of the exhalation from the soil. During the day the sun draws up the steamy vapour from the swamps; then, when evening sets in, the land night breeze springs up, and carries on its wings the exhaled

vapour to the coast. One final injunction in connection with evening malaria: no bathing parades should be permitted after the sun has set. Bathing parades.

Thus far we have tried, by selecting our men, and the season for operating, by properly clothing and feeding them, by attending to their life in camp, and finally by attacking the conditions appertaining to the life of the "ferment," to prevent the action of malaria. The men must perforce remain exposed to the morbific influence, which may yet flourish in despite of all the above measures.

Can any other measure be called in? In the words of Crudeli we can, in addition, "increase the specific resistance of the human organism to the poison." And this brings us to the question of the "antiperiodic ration."

Antiperiodic Ration.—Prophylactic rations were first tried in China in the shape of quinine. The drug was thought to have been of service, but no definite experiments were made. Quinine. China.

At Peshawur, however, in 1866, during the autumnal months when malaria is very rife, a trial of quinine was instituted. The different corps were divided into wings: the men in one wing having 5 grains every evening; the men in another having none. From September 1 to November 30, 1203 men took quinine, with an admission into hospital of 10.22 per cent. for malarial fever; 1202 men did not have quinine, with an admission rate of 27.28 per cent. for fever. Here the material, the place, the general conditions were the same, and hence this experiment *in corpore vili* is of much value. Peshawur.

The general opinion is certainly in favour of the ration. In America, after Van Buren had served on a sanitary commission in which this matter was taken into consideration, he stated that the daily ration of quinine was found to protect the men from malarial disease. Hammond also stated the same as the result of his experience in the civil war. Van Buren.

But there has been nevertheless opposing evidence. Thus the French in Algeria have not had good results. Sir Anthony Home again has recorded as the sum of his experience in the Ashanti war that he was unable to recognize any value resulting from the practice of giving a daily quinine ration. It seemed to him neither to ward off malaria nor to mitigate its attack. Algeria. Ashanti.

In the Malay war, again, a daily issue of 3 grains was ordered; after a while the issue was only on alternate days. The Ghoorkhas, however, did not receive the ration, and yet they suffered only very slightly more from "fever" than the Buffs who did. But, among the Buffs, the malarial fever which did attack the corps appeared one month at least after they had been regularly taking it. Malay.

Again, Tommasi Crudeli has found long-standing malaria to be actually aggravated by quinine. As negative evidence is of less value than positive, it is certain that quinine is of benefit on the whole. Are there, however, any superior substitutes? Crudeli would seem to have indicated one at least. Crudeli. Conclusion.

Arsenious acid.

In 1880, Crudeli proposed the trial of arsenious acid as a prophylactic to enable the labourers to remain at work on those malarious soils in Italy which were being reclaimed from malaria by high cultivation. In 1881, Dr. Ricchi, chief of the medical staff in charge of the Roman and South Italian railways, instituted experiments, but inasmuch as malaria was not rife that year, no important conclusions were drawn. In 1882, however, malarial fever was urgent; and to 455 workmen Ricchi gave one milligramme of arsenic, gradually increasing the quantity to eight milligrammes, daily. Of these 338 were either cured of fevers which they had, or prevented from contracting them, in 43 cases the results were negative. Amongst these latter cases were those who did not take the medicine regularly or only for a few days. In 74 cases the influence of the remedy was doubtful, but in these the medicine was alternated with other supposed prophylactics. Ricchi is convinced that "if arsenic is not always preservative against malarious infection, it renders the human organism less and less susceptible to the ferment of malaria." In 1883, the experiments were continued on 78 individuals in the Borino district. These 78 were divided into two sections, of which half took arsenic only. At the end of the fever season, those who had not taken arsenic had suffered from fever, many of them severely; whilst the others were nearly immune, 36 out of the 39 who had taken arsenic had had no fever, and the remaining three had had only slight attacks.

Ricchi.

Similar results have since been obtained in Bosnia; in the Tuscan Maremma; and amongst the men employed in the royal chases at Castelpasciano.

Researches have also been instituted on animals, by inoculating them first with malarious blood, then treating one-half with arsenic. The experiments are not yet complete enough for any result to be arrived at.

In addition to its antiperiodic action, arsenic has a tonic action well adapted for campaigns. "In Styria the men use it to enable them to undergo great exertion without fatigue, and they maintain that it enables them to climb mountains and accomplish fatiguing tasks utterly impossible without." The arsenic-eaters all belong to the lower classes, and are said to be strong, healthy, courageous and pugnacious.

Downie.

Again, Downie, of the Indian medical service, in his trials of arsenic as a prophylactic agent against malaria, has found his results superior to those from quinine.

Wilks.

Finally, no bad consequences ensue from a prolonged course of it. Dr. Wilks "has never observed any injurious effect from its long use, although, as is known, it becomes absorbed into the system."

Author's experience.

The results of my experience with this drug have so far not been in accordance with the foregoing. During 1886 and 1887 I placed the regiments I was serving with on a prophylactic ration of arsenic during the months in which malarial fever was to be expected. The men in each regiment being in both instances of

one caste and race, the circumstances of the experiment were not disturbed by any intrinsic factor.

In 1886 four companies of the 23rd Pioneers were ordered to take the ration, the remaining four companies not doing so. The table shows the result :—

Months.	Dose.	Total Cases of Malarial Fever.	Cases in Companies taking Arsenic.	Cases in Companies not taking Arsenic.
August . . .	5 minims bis die.	4	1	3
September . . .	Do.	6	5	1
October 1 to 8 . .	Do.	8	4	4
„ 9 to 31 . .	5 minims ter die.	17	9	8
November 1 to 12 .	Do.	9	6	3
„ 13 to 30 .	10 minims ter die.	4	1	3
December . . .	Do.	6	2	4
Total cases		54	28	26

Thus, the cases not taking arsenic had, indeed, fewer cases of malaria than those taking it. When the largest dose was given, the result was however different, but still the effect generally was not in accordance with expectation.

In 1887 the men of the 14th Sikhs were subjected to a similar treatment. The right wing took six minims of arsenic twice daily from September 20 to November 16. The result showed as follows :—

	Right Wing.	Left Wing.
Quotidian ague . .	3 cases	9 cases
Tertian ague . . .	4 „	Nil
Quartan ague . .	1 „	Nil
Total . . .	8	9

Here, again, no result was obtained.

Johannsohn, in his experiments on the action of arsenic on the yeast plant, concludes that the drug causes its degeneration. Arsenic would appear to have a twofold action in malaria. Reasoning by analogy, it would attack the malarial organism as it does the yeast plant, and secondly, "it increases the specific resistance of the red blood-corpuscle. If the blood in anæmia be examined whilst arsenic is being administered, it will be found that the disintegration of the red blood-corpuscle ceases. But, as we have seen, the malarial bacillus has an elective affinity for the red blood-corpuscle, on which it brings necrosis. The arsenic will thus both prevent the necrosis, and also stop any that is going on. Mode of action of arsenic.

Finally, Tommasi Crudeli has found its action superior to that of quinine, longer in duration, and more beneficial to the general nutrition.

It is also far cheaper than quinine. Under these circumstances it is worthy of trial.

Lemon-juice.

In many parts of tropical and sub-tropical regions we should probably be in a position to obtain lemons or limes. If so, as far as possible economize their use. Dr. Maylieri has found a decoction an excellent prophylactic against malaria. The fresh fruit, rind included, is cut into thin slices, then boiled in three pints of water, until the fluid is reduced to one-third. It is then filtered and strained, and allowed to cool. Cervello of Palermo, Ferrarresi of Rome, and Mascagni of Arezzo have experimented largely with this remedy, and obtained excellent results. M. Colin, again, advises black coffee to be given as a prophylactic, considering it superior to quinine. Dr. Moore, of the Bombay service, holds that opium-eating is in a measure prophylactic. He instances a severe outbreak at Jondpoor in 1863, in which every man attached to the political agency was attacked with malarial fever except two, who were opium-eaters.

Coffee.

Opium.

Iodine.

As regards other prophylactics, no good results have been elicited. Atkinson, of Maryland, in an exhaustive paper on the influence of iodine, has shown the latter drug to have very little influence, which influence was only exerted after a long administration of the drug. In the large majority of cases no effect whatever resulted.

Alkaline salicylates. Tincture of eucalyptus.

Alkaline salicylates have been tried. Their action is doubtful, and they are not efficacious as prophylactics. As regards eucalyptus, it appears to have established quite a false reputation as regards malaria. Aitken, of Rome, has shown that the influence of the eucalyptus on the malaria of the Campagna has resulted only in a costly failure. The plantation at the Tre Fontana, which the zeal of the Trappist monks has kept in a flourishing condition, has done little or nothing to remove the bad reputation for malaria of this region. The monks still succumb to malarious fevers, whilst the proposal to send convicts to assist the monks in extending the plantations, carried into effect, has had to be given up owing to the mortality incurred from fever. The eucalyptus simply acts by withdrawing water from the soil. This action was forcibly brought to my notice when on leave in New Zealand. At a country-house, formerly surrounded by a well-stocked plantation, no other living tree was to be seen but the eucalyptus. This result had ensued on adding to the plantation specimens of eucalypti. They rapidly grew up, and derived so much moisture from the soil as to kill all the other trees.

Hospital Ships.—A short reference to the location of hospital ships on malarious shores is necessary. Their employment in campaigns has been attended lately with the greatest benefit. How far off should they, therefore, be anchored from the shore? Does sea-water stop the horizontal spread of malaria? The evidence is conflicting. Various distances, on the one hand, have been laid down relative to the horizontal spread over sea-water of malaria—*e.g.*, for China three-quarters of a mile, for the West Indies one mile, were found necessary. But, on the other hand,

in the Ashanti war, ships could be anchored close off Cape Coast without any risk of remittent fever. Cornish shows that rice fields exposed to sea-air are not sources of malaria; and, finally, Hirsch lays down that the crews of ships lying so close in shore as to be of necessity affected by the land wind, are, according to experience, almost always exempt from malaria so long as they do not set foot on shore. But here, again, we find opposing evidence. Parkes gives an instance of the passage of malarious fever over half a mile of water, in the case of the s. *Pylades*, anchored off Manzanilla, one of the most malarious places on the coast of Mexico.

There can be no question on one point. A hospital ship should never be anchored in a river debouching into the sea in a malarious district. Dickson shows how, in the Congo River, the boat crews suffered, whilst the crews in the ships lying off the shores did not; and, again, how malarial fever attacked the crew when his ship lay in the San Juan de Nicaragua, in Central America.

As regards the open sea, experience at the spot can alone decide the question; but, as a rule, a ship can be anchored sufficiently close in for the sick to be conveniently brought to her.

Infection of Malaria.—Another point must yet be considered. Is it necessary to look upon malarial fever as an infectious fever? This question arose in the Ashanti war. The sick who were sent on board the *Simoom* were mainly suffering from malarial fever. After a time, suspicion arose that the fever might be acquired by infection. In one case, an "infected" officer had not been ashore for a month. He was then seized with remittent fever. It was, however, found that a distinctive smell lay about the lower deck apportioned to the officers. May not, therefore, there have been conditions in the ship appropriate for the life of the malarial "ferment?" This is far more probable than that the disease was caught from another patient. I have never seen the slightest cause for thinking malarial fevers are infectious. Hirsch brushes away the notion that a contagion develops in the course of the malarious fever capable of reproduction in the body of the patient, elimination, and conveyance to another individual.

The black disease of the Garo Hills.

Amongst the Garo Hill people, a severe malarial fever exists, which the Garos term the "black disease," and believe infectious. The people will not communicate nor associate with affected individuals. They live in the lowlands in the midst of thick jungles; the people work in this jungle, clearing it away, and break up the ground of this swampy undrained region. Surgeon-General T. Clarke, who has investigated it, however, says that "there has been no evidence adduced by Europeans to prove this belief true, and that it is probably unfounded." The question has recently (1885) again been investigated by Dr. Dobson. He finds the disease is only malarial fever, and that there is not a particle of evidence that it is infectious.

Acclimatization.—We come, finally, to the question of acclimatization. Can "acclimatization" help us? It cannot. We have already seen this partly when discussing the selection of

troops. The question has an important bearing on the garrisoning of any port for a long period. Such a garrison should not be left too long without change.

Wenzel. Wenzel, from a large experience, held that no immunity was obtained from a long halt in a malarious country; but he held, nevertheless, that the attacks became rarer and less intense. This is contrary to our experience, and apparently contrary to all experience. The French in Algiers found that the mortality increases with the stay. Nothing, also, shows this clearer than the medical history of the Ashanti expedition of 1863.

Crudeli. Tommasi Crudeli distinctly affirms that individual acclimatization never has been, or can be, possible. If it were, how great an aid we should have in our campaign! The only acclimatization possible is that of a race by the process of selection, in which malaria during a long course of ages carries off all whose specific resisting power is weak, leaving only those whom it cannot conquer.

Hirsch. Finally, Hirsch, who admits acclimatization so far that immunity is acquired relatively in proportion as the individual has been continually exposed from birth to maturity to more or less severe malarial influences without suffering from them to any considerable extent, expressly states that nothing so much increases the predisposition to malaria generally, and to its severe forms in particular, as repeated infection. Conclusion. From all this we learn once again the great importance of selection; in malaria we do *not* want "seasoned" soldiers in the sense of troops seasoned in malaria; on the contrary, such are rigorously rejected.

CHAPTER III.

OPHTHALMIA OF ARMIES.

THE Egyptian war of 1882 gave to the history of military medicine a striking example of the effects of good hygiene. To show this, I must first draw attention to bygone experience. Contagious ophthalmia has been for a long time endemic in Egypt. But the disease did not appear as a disease universally affecting European armies before Napoleon's expedition to Egypt in 1798. In this expedition, after disembarkation, within two and a-half months the French had 3000 sick of the disease before Alexandria. In 1801, in the English expeditionary force to Egypt, the most formidable disease after plague was ophthalmia. Of the Indian contingent alone, fifty were invalided blind, whilst the French are said to have sent home 1000 men deprived of sight. Now, in 1882 we were campaigning again in this endemic region of ophthalmia. Again, also, columns of invasion were sent forth from England and India. But what a contrast is presented with regard to this disease! Amongst the troops from England there were 1783 admissions for ophthalmia from July 17, 1882, to January 29, 1883, but not a man lost his sight: whilst in the Indian contingent there were 182 cases, or 32.07 per 1000; again not a fighting man lost his sight.

In our tropical and sub-tropical campaigns outside Egypt we have not had much experience in ophthalmia. In China and in Zululand there appear to have been a few cases, but, with the exception of Egypt, we have not found the disease rife in any country. In the Nile expedition 1884–5 there were 511 admissions for eye disease. Of these, 486 were due to conjunctivitis. In the Suakim expeditionary force of 1885 there were only 49 cases, or 6.8 per 1000. In any campaign in Persia the military surgeon should take special precautions.

Nature of the Disease.—Roth thus introduces the subject: "Amongst the contagious diseases of the eye, only the granular inflammation of the conjunctiva possesses a pronounced tendency to epidemic development amongst troops, which from its earlier and great spread in armies became designated military ophthalmia."

Let us, therefore, briefly describe the anatomy of granular ophthalmia. And, first, two conditions have been described under this term, both of which indeed take part in the production of the disease.

Under the continued irritation of a mechanical or other irritant

Papillary granulations.

acting on the conjunctiva, especially when combined with bad sanitation, a simple catarrh thus primarily arising may at length produce (1) a discharge of a contagious character capable of reproducing the disease in others, and (2) it may produce hypertrophy of the papillæ of the conjunctivæ. The papillæ at first become congested, then enlarged and villous. The "granular" lid condition is thus produced. These enlarged papillæ, by affording an increased surface, enlarge thus the area of inflammation, and also, of course, add to the inflammatory products. These inflammatory products have also by this time acquired a contagious character, and by contact can inoculate the disease on a recipient.

Follicular granulations.

But a much more important granulation is the so-called "follicular granulation." The discharge primarily developed from a simple catarrh as stated above will light up a severe inflammation in eyes in which "follicular granulations" are developed.

Military ophthalmia was first introduced into Denmark by the German troops in 1848. Dr. Löffler, the surgeon of the introducing Prussian regiment, investigated the disease, and found that many eyes were affected by granules under the conjunctival epithelium without any further change, and also that inflammation generally started in those eyes which had these granules. Hence he said that the "granules" were the first stage of the disease.

Next, the question arose whether these "granules"—soon called "sago grain"—were pathological, or arose from pre-existing normal histological structures. Stromeyer advocated the former, and Krause the latter view. The latter was proved correct by Dr. Schmid, who found the conjunctiva in newly born animals to contain lymph cells, generally distributed in an adenoid tissue; which, as life went on, became aggregated into distinct follicles, forming part of the normal structure. As seen, therefore, in this contagious ophthalmia by Löffler, they were merely hypertrophied. The follicles obtained the name of the follicles of Krause, and hence the "sago-grain" granulations are really a hypertrophied condition of the elements of the solitary follicles of Krause.

The causes of the hypertrophy of Krause's follicles will be adverted to presently. Meanwhile, it has been established that the hypertrophied follicles do not necessarily give rise to inflammation, but they predispose powerfully to it. As Brudenell Carter well puts it, these follicular granulations are like tinder, to which any accidental circumstance may apply a spark. In the preventive treatment, therefore, of military ophthalmia when due to follicular granulations, the military surgeon has both to prevent the circumstances causing the hypertrophy in the first instance, and, if not soon enough on the spot for this, he must next prevent those accidental circumstances applying the spark to the tinder.

Summary.

Military ophthalmia, therefore, may arise—

(1) From a primarily simple catarrh becoming purulent and acquiring contagious characters. It is impossible to say when

the discharge becomes contagious, or to assert the non-contagiousness of an inflammatory conjunctival discharge.

(2) From the secretion of "papillary" granulations arising from catarrh. Roth states that the secretion of the "papillary" granulations is much more contagious than the purely catarrhal secretion.

(3) From an inflammation engrafted on the "follicular" granulations, resulting from hypertrophy of Krause's follicles.

We have, therefore, to combat the causes—

(1) Of a primary simple catarrh becoming purulent or causing formation of papillary granulations.

(2) Of the hypertrophy of Krause's follicles.

(3) Of the inflammation engrafted on Krause's follicles when thus hypertrophied.

Etiology.—The influences bringing about infectious ophthalmia arising primarily from catarrh or from papillary granulations are identical with those bringing about the disease from hypertrophy of Krause's follicles. The same cause underlies each class. Thus, the Ophthalmological Congress held at Brussels in 1857 declared: "Facts show that under the influence of irritants acting on the eye when the hygienic arrangements are bad, and especially when there is overcrowding, a catarrhal, sporadic, or endemic ophthalmia can assume the character of the so-called Egyptian ophthalmia, and become the starting-point of an epidemic." The especially dangerous character of the secretion of the resulting papillary granulations is then pointed out. (*a*) Of catarrhal epidemic ophthalmia, and "papillary" granulations.

The same relation of over-crowding to hypertrophy of Krause's follicles is insisted on by all observers. Thus, Leith Adams urges that this condition is induced by the contents of foul air of crowded barrack-rooms. Stromeyer has also induced it in pigs by confining them in a vitiated atmosphere, having at the same time made control experiments with the same animals under exactly the same conditions except confinement. Welch also states that it is due to living in an atmosphere vitiated by the excreta of the breath, skin, and body. Frank likewise urges that it indicates a vitiated atmosphere. And, lastly, we have the negative proof that under our existing improved barracks grey follicular granulations have practically disappeared. To this, indeed, must be attributed primarily the remarkable result of the Egyptian operations of war of 1882 as regards ophthalmia. The men here did not set out predisposed to it. (*b*) Of "follicular" granulations.

Surgeon-Major Welch has shown that age has a certain influence on the occurrence of hypertrophy of Krause's follicles should the cause be present. He found the occurrence of this hypertrophy amongst the cases in the following ratio as regards age:— Age.

15–19 years of age	73.3 per cent.
20–24 " "	56.7 "
25–29 " "	52.3 "

Hence, we see that our soldiers enlist at an age which is most

prolific as regards these granulations, whilst their chief service is performed at an age when the tendency to them is far greater than at subsequent ages. Dr. Welch found their occurrence to be far rarer at ages beyond twenty-nine.

Exciting causes.

A *catarrhal ophthalmia* having resulted in a purulent inflammation, or in the formation of secreting *papillary granulations*, the secretion, in both cases, will now be capable of starting an epidemic by contagion from towels, washing-basins, or cloths, &c., accidentally conveying the secretion. The air also greatly acts as the medium of infection. Thus, Eiselt demonstrated the presence of pus cells in the air between the several beds of a ward filled with patients suffering from acute blennorrhœa of the conjunctiva. He thinks that any strong stream of air passing over the infected eyes is capable of bearing away with it some of the pus cells; these, then, alighting on the eyes of a healthy individual will propagate the disease. Stellwag von Carion, however, doubts this action of the air; he holds that infecting particles can be diffused into the air by the sticky secretion forming little bladders between the lids, which then burst and so infect the air. At any rate, infection in some way by the medium of the air was declared by the Ophthalmological Congress of Brussels to be the most frequent source of propagation, the infection by towels, &c., coming next. This infection by means of the air must therefore be borne in mind in the matter of prevention. And in the matter of infection by the air, it must be noticed that the dried particles of secretion are much more frequently the carriers of contagion than the moist. Quite recently Prof. Michel, of Würzburg, has found a specific microbe in an outbreak of granular ophthalmia in the orphan asylum of Aschaffenburg, and states that, by puncture experiments made with small quantities of the coccus obtained by culture, true trachoma can be induced in the human eye.

Through the air.

The follicular granulations, as has been shown, do not necessarily give rise to inflammation, but powerfully predispose to it. Various agencies readily excite the disease. A few of these may now be considered.

Glare of sun.

Imprimis, the constant glare of the tropical sun has a very injurious effect on weak eyelids. In an epidemic in the 22nd Regiment, to be presently described, the men did not wear any peaks to their caps. The natives of the Himalayas instinctively wear over their eyes shades made out of leaves. The glare of the sun through the thin bell tents at Talien-whan excited it. Dirt and dust may call it into activity. Dr. Leith Adams, however, has shown that dust is not such an active agent as might be supposed. In Scinde and in desert countries, where clouds of impalpable dust are constantly whirled about by the winds, he says that those most exposed suffer least from ophthalmia. The Arabs of the desert have bright clear eyes. Again, in Malta the officers and residents do not suffer, although under the same conditions of dust as the soldiers. Burton says "ophthalmia is unknown in the desert." However, dirt and dust do

Dirt, dust.

excite an influence, as was shown in the late Egyptian operations of war. Here there were only thirteen cases of ophthalmia amongst the Indian cavalry. The cavalry in question were camped away from the dirt and dust of Cairo, towards the desert; and the men again, when mounted, were removed, in a measure, from the desert strata of dust in the atmosphere.

Flies are certainly agents in the conveyance of inoculation. No one can doubt this who has seen the swarms of flies settled on the everted, inflamed lids of the unfortunate old men and women and young children in the bazaars of Suez. Hence it is of importance to keep flies out of the tents as far as possible. Flies.

Towels and basins may carry the infection, as before noted, from a previous case, and thus set fire, as it were, to the follicular granulations. Towels.

In the Indian contingent in the late operations of war in Egypt, of the 182 cases treated, 100 occurred amongst the Europeans, in the ratio of 58.36 per 1000, and 82 amongst the native troops, or 20.7 per 1000, of strength. The latter did not, of course, use basins, whilst it is believed that the Europeans did not always use sufficient care in their ablutions, several using the same water for washing their faces, and thus spreading the disease.

Again, in addition to the methods of air infection pointed out previously, during sleep, when the eyelids are closed, contagious particles can find their way into the air by being carried down the lachrymal passage, and thence carried into the air by expiration. Brudenell Carter suggests that the conjunctivitis may be attended by a development of leptothrix, arguing from the analogous development attending many disorders of the tear-passages. "In that case the floating spores of the fungi would also serve as carriers of contagium, even if the fungoid growth itself may not sometimes constitute the essence of the disease."

Before passing on to indicate precisely the precautions to be taken in a campaign, it is necessary to say a few words about climate in relation to ophthalmia. Inasmuch as ophthalmia is not present in all hot climates, there must be some limited cause not dependent directly on climate. However at the present time infection can account for the presence of the disease in Egypt, yet at the origin the hot glare could not have acted. The country round Sibi, in Beloochistan, seems very similar to the general aspect of the country near Suez. Yet I never saw a case of ophthalmia in a native Beloochi, although there were present storms of sand, blinding glare, and intense heat. But the natives of Beloochistan live in scattered villages, the general sanitation of which is far superior to that of Suez and Port Said. Ventilation is generally free through the lanes of the villages. Again, in the cities and towns on the Persian Gulf the same conditions of climate, plus insanitation, however, appear present, as in Egypt. In fact, the real element in the affection is insanitation. Climate. Want of sanitation.

I will now proceed to sum up the precautionary measures

to be undertaken when campaigning in a country in which ophthalmia is known to be present.

Selection of Men.—At the present time, selection does not play the important part it would have played years back. We are not likely now to meet with many cases of hypertrophy of Krause's follicles, on account of the results that are accruing from the application of sound principles of ventilation to the soldiers' barracks. Should any men be suffering, however, from follicular granulations, they should imperatively be weeded out; also a man who has once had the disease, for nothing is more sure in the clinical history than that relapses are certain to take place under a fresh exciting cause. In the East Soudan expedition, 1885, nearly all the men who were admitted for eye disease had had "keratitis."

Again, all weakly or debilitated men, apart from other reasons, are to be left behind, for they are chiefly attacked in any epidemic of the disease. The examples of the disease in the Indian contingent in Egypt were all in debilitated subjects.

Selection of Season.—The hot season of the year especially helps the spread of the disease, and a combination of heat and moisture is still more powerful. An instructive medical history in this respect is given by Dr. Leith Adams concerning the 22nd Regiment. The regiment, 838 strong, having no previous history of ophthalmia, sailed for Malta in June 1860. Before the end of this year there were 40 admissions for the disease. The majority of these occurred in August and September, when the moist sirocco was felt greatest. The number of cases rapidly decreased during the cold months. It reappeared during the hot months of 1861, and again, similarly, in 1862. During 1863 it became fairly established in the corps, and, moreover, was now extremely obstinate. The weekly average rose from 0.23 in 1862 to 8.18 in 1866, when the regiment left for Canada. In 1868 in Canada it lessened to 4.01. In 1869 the rate was 2.37, and the regiment returned to England. In 1870 the disease was extinct. The warmth and moisture of the sirocco must predispose to increased weakness and vascularity generally, and, therefore, of the conjunctiva. The great prevalence of the disease on the shores of the Persian Gulf, is probably favoured by the moist, depressing nature of the heat in places.

Clothing.—During the Egyptian operations of war of 1882 especial precautions were taken by providing the men with goggles and veils to protect them from sand, dust, flies, &c. Pieces of mosquito netting were used by Colvin Smith in the Indian force to keep off the flies. In connection with the subject of clothing it may be mentioned that Dr. Vleminck formerly denied the contagious properties of the disease, and affirmed that it was due to the pressure of a certain new form of collar and shako. He, putting theory into practice, sent away to their homes 4000 men affected with the disease. He thus freed the army. Unfortunately, however, for their relations, the men, on their return, spread the disease far and wide.

Marching.—After each march the men should be directed to wash their faces and eyes at the earliest opportunity. This was done with good effect in China in 1860. And with regard to washing the eyes, the men should be directed to dip their eyes opened in water; the water, thus acting freely on the conjunctiva, will tend to brace up the mucous membrane and counteract any tendency to relaxation. And whilst on the subject of washing, it is important that each man have his own towel; that a number of men do not wash in the same basin; that the towels be kept separate from one another; that when wet they be not hung up in the men's tents, but out in the open; and that after one man has used a given basin, it be rinsed out with water before the next uses it. In the Zulu war the men were directed to bathe their eyes freely. Marston has also called attention to the importance of the men cooling themselves after a march without throwing off their clothes, unless they make a complete change. He lays stress on this caution, as constituting a great preventive against ophthalmia.

Camp.—The tents of the camp must be separated as widely as possible, in order that the air may be as pure as possible. The proper amount of, and renewal of, air is of the greatest moment. It is manifest that the average high temperature of the tropics must in a close camp decompose quickly the excreta of the breath and skin, and thus vitiate the air. The vitiation of the air thus produced appears to be a powerful factor, as we have seen, in exciting proliferation of the cells of the follicles. The soil to windward of the camp should be watered in order to lay the dust, and, should any grassy expanse be present, the camp should be pitched on it. Flies should be kept out of the tents by "chicks" before the doors. Dr. Colvin Smith found carbolic spray of great use in keeping flies out of the room in the Egyptian expedition of 1882. Finally, Laveran cautions against sleeping outside tents in warm countries in campaigns, especially where there is great alternation of heat by day and cold by night.

Conservancy. — Strict attention must also be paid to the conservancy of the camp. Dr. Du Chaumont has drawn attention to this factor in accounting for the greater prevalence of ophthalmia at Malta as compared with Gibraltar. "The rock at Malta is exceedingly absorbent, whereas that at Gibraltar, being of mountain limestone, is much less so." No pipes are laid down, but only channels are simply cut through the porous rock; thus the soil at Malta is more or less saturated with fæcal matter. Welch has also pointed out the etiological influence of the fæcal excreta. Again, one cause of the greater prevalence in Egypt than elsewhere is doubtless the absence of rain, causing the soil to be exceedingly light. Owing to the unsanitary state of the cities and natives, the fouled soil is blown about; the atmophere is laden with minute particles of dried excreta.

Food.—The influence of an insufficient and unvaried diet has been insisted on by Brudenell Carter in causing the development of follicular granulations amongst children. Also he draws atten-

tion to the part played by bad water. The *Lancet*, in commenting on the epidemic of ophthalmia at Anerley Schools in 1872, drew attention to the poorness of the diet. Apply the same to our soldiers, and we have another reason for varying their diet as much as possible, and for making the quantity of the ration proportionate to the work to be done. With regard to the water, I need only refer to the section on Purification. In connection with diet, it may be noticed that Inspector-General Taylor in his report states that scurvy at the Cape caused granular ophthalmia. If so, the necessary precaution is obvious.

Inspections.—Finally, there should be daily inspections of the men when campaigning in a country where ophthalmia is rife, in order at once to catch the earliest case.

The men also should be warned to report themselves to the medical officer should they feel any "grit in the eye."

Treatment of an Outbreak.—Should, notwithstanding, an outbreak take place, our efforts must be directed to limiting it. The strictest isolation of sick from healthy, and of men with any follicular hypertrophy from both; each man must have his own towel and basin; the freest ventilation possible must be given. Looking at the remarkable results obtained by Credé in the prophylaxis of purulent ophthalmia of new-born children, in which only two cases occurred in 1000, these two cases having neglected the treatment, it would be advisable on the outburst of an epidemic to give each man for a few days an instillation of a drop or two of a 2 per cent. solution of nitrate of silver. (In the German lying-in institutions owing to this treatment the cases of purulent ophthalmia have fallen from 15 to 0 per cent.) The sanitary condition of the hospital, the camp, and the surroundings must be inquired into, and any defect remedied. By these means an epidemic can be stamped out.

No man is to be dismissed from hospital until all secretion from the eye has ceased; and, inasmuch as the tendency to relapse is great, he must be instructed to report himself daily (and at once on suspicion of any fresh symptom arising).

Subsequently the towels, basins, bedding, and tents must be disinfected. The indications for disinfection have been previously laid down, and it need only be repeated here that the best disinfectant for the above is a solution of mercuric chloride of the strength of 1–1000.

CHAPTER IV.

SCURVY.

I will first, with regard to scurvy, examine the medical histories of the various campaigns in hot climates, commencing with the first Burmese war.

In the first Burmese war, the European force in Ava gave "the most terrible instance" of scurvy, 48 per cent. perishing from scorbutic dysentery in six months. First Burmese war 1824–6: scurvy.

In the China war, at an early period of the campaign, scurvy showed itself in certain regiments. At the end of May the troops began to leave Hongkong for the Gulf of Pechli. The voyage to Talien-whan Bay, the place of rendezvous, occupied about twenty days. During this time the men lived on salt rations chiefly. On disembarking at Talien-whan Bay, the 19th P.N.I. and a wing of the Buffs showed scurvy. Daily inspection was then ordered, fresh meat and lime-juice given, and the disease soon disappeared. China, 1860: scurvy.

In the New Zealand war, fresh meat and vegetables, especially potatoes, were, with rare exceptions, always available in abundance. When salt meat was given, $\frac{1}{2}$ oz. pickles and $\frac{1}{12}$ oz. mustard were allowed. Lime-juice also was then issued. There was no scurvy. New Zealand, 1863–5: no scurvy.

In the Bhootan expedition scurvy severely attacked the force. Bhootan, 1864: scurvy.

In Abyssinia the troops were extremely well fed till the transport broke down. Fresh meat was largely supplied and often fresh vegetables. After Antalo, the meat ration was increased, and compressed vegetables given. The advance from Antalo and storming of Magdala occupied about a month. It was through a highland country. No scurvy occurred amongst the British troops, but severely did it affect the native troops in one case—viz., the 21st P.N.I. Abyssinia, 1867: scurvy.

In the Looshai campaign, towards the end of the operations, scurvy appeared very generally in the right column, especially in the 2nd and 4th Ghoorkhas. The men of the Ghoorkhas had scarcely touched vegetables since they set out from Chittagong. Again, in the 27th P.N.I. the want of fresh vegetables, spices, curry, and sugar, with only an occasional ration of meat and scarcely any milk or fruit, seriously affected the health. Colic, flatulence, loss of appetite, and diarrhœa set in, followed by scurvy. The men complained most of the want of sugar and dried spices. Again, a great proportion of the dysentery that occurred from a like diet in the 44th L.I. was of a scorbutic nature. Lime-juice and sugar were issued as far as possible. Later on a daily ration Looshai, 1871: scurvy severe.

of lime-juice was obtainable; and at the advanced posts a timely supply of yams and pumpkins aided in suppressing the symptoms.

The Peshawur mountain battery reached Abbottabad after the termination of the campaign. Scurvy was then prevalent to the extent of 46 per cent. of the Mussulmans and 16 per cent. of the Sikhs of the battery. The battery had had no fresh vegetables, or only a very scanty supply. Dr. W. Johnston thought the greater immunity of the Sikhs was due to the arum, onions, and garlic contained in their curry powder.

Ashanti, 1873: no scurvy.

In Ashanti scorbutic affections were known to prevail on the Gold Coast, and it was expected that scurvy would appear. Lime-juice was accordingly provided at every station and camp. It was given to the men at sea in the transports. Fresh oranges and limes were also found in the country. After a time fresh vegetables were also procured. The field ration was also more varied than usual. Pickles were provided. No scurvy appeared.

Duffla, 1874: no scurvy.

The Duffla campaign was conducted under very similar external circumstances as the Looshai. Mindful of the outbreak of scurvy in the latter, a daily issue of a vegetable ration and $\frac{1}{3}$ oz. lime-juice was ordered per man. There was not a symptom of scurvy during the campaign. Although fresh meat was laid down in the scale of rations to be distributed only three times a week, yet, as a matter of fact, fresh meat was given nearly every day, it being cheaper to drive sheep than to carry salted provisions. Besides the above, there was a weekly issue to every twelve men of 1 bottle of mustard, 2 oz. of pepper, 2 pints of vinegar, $2\frac{1}{2}$ lb. of pickles, and 7 oz. of curry powder.

Sunjhie-ujong, 1874–5.

In the Sunjhie-ujong column lime-juice was served out whenever salt meat was issued.

Malay, 1875–6; no scurvy.

In Malay abundance of fruit was obtainable. Potatoes or yams, and fresh meat, were supplied. After a time, however, a salt-meat ration was issued once a week, but with it a weekly allowance of pickles (6 oz.), vinegar ($\frac{1}{6}$ pint), mustard ($\frac{1}{2}$ oz.), and pepper ($\frac{1}{6}$ oz.) Two months after the commencement of the Malay expedition 2 oz. of lime-juice were issued twice a week.

There was no scurvy in these columns.

Afghanistan, 1878–80: scurvy.

For the European force pickles were ordered to be given twice a week irrespective of the nature of the meat ration (salt or fresh). If fresh vegetables were not procurable, 1 oz. of dhall and 12 oz. of compressed vegetables were given. Pickles and vinegar were given always with the pork ration, and also twice a week as above. During General Roberts' march lime-juice was issued daily. Scurvy was very slightly present in the European troops, but, as will be seen hereafter, was largely prevalent amongst the native troops owing to their insufficient diet and absence of prophylactics.

Zululand, 1879: no scurvy.

In the Zulu war there does not appear to have been any scurvy. Fourteen days after taking the field, lime-juice (1 oz.) was issued whenever fresh vegetables were not procurable. Peas and beans were issued only when other vegetables could not be procured; rice was only issued in lieu of other vegetables, also on

the special recommendation of the medical officer. There was also ordered a weekly inspection for the detection of the disease if present.

In the besieged garrisons the health was maintained splendidly. Scurvy is especially liable to attack the besieged. However, here no instance occurred. At Standerton the vegetable ration ran short; lime-juice was promptly given. At Potchefstroom, although the rations were reduced to less than half a pound of meat, yet lime-juice was abundant. No scurvy occurred. Natal and Transvaal, 1880: no scurvy.

During the operations of war in Egypt in 1882 only one case of scurvy is reported. Scurvy was amongst the diseases to be apprehended in Egypt. Prophylaxis was especially attended to. After the troops took the field a lime-juice ration was given. Red wines were issued. Especial care was taken in providing lime-juice when no fresh vegetables were procurable, or when preserved vegetables only were obtainable. Finally, frequent periodical inspections of the gums were made. In the Indian contingent also no cases occurred. Lime-juice was regularly issued. Egypt, 1882: only one case of scurvy.

In Aka there was no scurvy. On account of the abundance of wild fruits, forming excellent anti-scorbutics, a lime-juice ration was not issued. Aka, 1883-4: no scurvy.

In the East Soudan in 1884 also there was no scurvy. The expedition was only for a short time (three weeks). Fresh and preserved meat rations were taken, and a ration of lime-juice given. E. Soudan, 1884: no scurvy.

In the Nile expedition only five cases, or 0.46 per 1000, occurred amongst the regular forces, and twelve cases amongst the Kroomen. It was stopped by an increase in the lime-juice ration. Nile expedition, 1884-5: very little scurvy.

From the foregoing short *résumé* we find that scurvy broke out (1) where fresh vegetables were wanting; (2) where, with absence of fresh vegetables, no lime-juice was given. We also learn some of the preventive measures necessary, such as the issue of lime-juice, red wines, pickles, avoidance of peas and beans as substitutes for other vegetables, &c. In fact, these histories teach us what to avoid, and what to give, for the prevention of the disease. I propose now to expand these questions in the first place, and in the second to offer some remarks especially on diet in relation to scurvy in the native army.

Nature of Scurvy.—Villemin contends that scurvy is a *contagious disease* analogous to typhus; this idea need not detain us; doubtless the affection of many men in quick succession or simultaneously led to this opinion, supported by the facts seen in the Crimea, in which campaign both scurvy and typhus were rife. Villemin.

Damp cold air has been considered to be the essential cause by many, inasmuch as scurvy frequently appears both on land and on sea under this condition. It is manifest, however, that this will not answer for many cases, especially for scurvy in the tropics. It may, however, predispose to it, inasmuch as it can render men more liable to the invasion of any sickness; in the same way, also, insufficient ventilation acts as a predisponent (Roth and Lex). The scurvy present in the 21st P.N.I. in the Abyssinian war was Damp cold air. Bad ventilation.

much aggravated during the return voyage to Bombay. The weather was rough and boisterous, and no ports or hatches were open. Consequently, the air at times became very foul.

Food.

These views being excluded, the evidence is overwhelming that scurvy follows a certain diet inevitably, and that is one in which fresh vegetables are excluded without compensation. Nor need the diet be otherwise a poor one; in other respects, as Hirsch states, there may be abundance, but the essential and constant cause is a want of vegetables.

Absence of fresh vegetables.

Inasmuch as attempts have been made to set aside this etiology, it is necessary to examine the question somewhat minutely.

The positive side of the question is quite in favour of the essential cause being in the absence of fresh vegetables. The histories of the campaigns before given show this. Delpech, at the siege of Paris, again demonstrated that the sole condition which was met with in all the observations on scurvy was the want of fresh vegetables in the food. In India, during the seasons when there is a scarcity of vegetables, or when vegetables are dear, scurvy appears in the native army, as I shall show later on. In Burmah, again, the same difficulty happens at certain seasons as regards vegetables, and the same consequence occurs. In the Crimea, as Dr. Macdowall has shown, scurvy appeared (although there was a liberal allowance of fresh meat) with the absence of vegetables.

But attempts have been made to assail the position from the negative side—that is to say, that scurvy does not occur in cases where vegetables are not procurable, provided fresh meat can be obtained. And associated with fresh vegetables, lime-juice (their substitute and adjuvant) is also included in this view—the view, namely, that neither are of much use. The theory of the fresh-meat anti-scorbuticism, or, rather, of the preventive properties *per se* of fresh meat as an anti-scorbutic, has been completely annihilated by Brigade-Surgeon Cameron Macdowall, of the Bombay Army, by whom the inconsistencies of its advocates have been exposed. Thus, it has been stated that the natives of Afghanistan and Beloochistan escape scurvy because they live almost entirely on fresh meat. Dr. Macdowall shows, first, that they do not escape scurvy, the disease being shown to be frequent by the entries in the civil hospital at Quetta; and, secondly, that they do not live almost entirely on fresh meat, inasmuch as, on inquiry, he found milk and wheat bread to form the staples of their diet, and really that they only eat meat about once a week; whilst as regards vegetables, they partake freely of wild watercress, onions, shallots, &c., melons and pumpkins and other fruit being also abundantly eaten in season. With regard, again, to the supposed immunity of these races from scurvy, Dr. Charles, in the Boundary Commission, found scurvy exceedingly prevalent among the Heratis and the Amir's soldiery. In fact, the Eastern races seem far more affected than Europeans by the disease. Again, to show the anti-scorbutic properties of fresh walrus meat, it has been

stated that the Laplanders, Greenlanders, and Icelanders have scarcely any vegetables, yet no scurvy. But the milk of the reindeer is abundant; and also they preserve carefully and eat the vegetable contents of the first stomach; whilst, finally, in summer they eat of cruciferæ and lichens. Thus it is not the case that the fresh meat of the walrus alone forms their diet.

In the *Polaris* expedition, again, the wrecked men had, besides fresh walrus meat, pemmican stuffed with raisins, currants, and plums. In the *Eira* expedition, besides the fresh walrus meat, the men had preserved vegetables. And, finally, Dr. Macdowall shows that scurvy is *not* absent in Iceland, Lapland, and Greenland, but, on the contrary, is common enough. Again, after the Punjab war of 1848–9, our troops were greatly in want of fresh vegetables owing to all husbandry having been interrupted; plenty of fresh meat, however, was obtainable. Yet scurvy appeared in several regiments, and fresh vegetables had to be brought up from a distance to cure it. We may therefore presume that scurvy is due to the absence of some constituents of vegetables. By a process of exclusion, it is supposed that if the salts contain the anti-scorbutic elements, as it seems most likely they do, then the salts in question are those whose acids form carbonates in the system. Roth, however, seems to doubt this, as he points out that citrate of potash will not act as a substitute for lemon-juice. Nevertheless, an excess of free acid in the system has something to do essentially with the occurrence of scurvy. Fresh vegetables are far more anti-scorbutic than preserved, consequent on certain changes which take place in preserved vegetables. These changes are probably very similar to those that take place in the saccharine elements, as we see in fodder preserved by ensilage, in which there is an increase in free organic acid, whilst the amount of alkaline bases remains the same. Now, the organic salts whose acids form carbonates in the system will thus counteract and neutralize this excess of acid. So much for the theory of the action of *fresh* vegetables. They keep up the necessary alkalinity of the body.

Polaris expedition.

Eira expedition.

Drinking-water, as a cause, will be alluded to presently.

Drinking-water.

Coming now to the practical aspect of the question, I will first speak of selection in relation to scurvy in the tropics.

Selection of Troops.—(1) Beware of a regiment with a previous scorbutic history. The scorbutic taint pervades those previously affected for years after, and is ready to be evoked prominently on but slight occasion. It, moreover, predisposes to tropical disease generally.

(1) Previous scorbutic history.

(2) As regards native regiments, employ, if possible, those regiments for particular regions whose men belong to those regions. In expeditions, for instance, in Assam, or in the hills bordering Bengal, employ down-country regiments. Do not bring up-country regiments down to these regions. They will find, on arrival, the food they have been hitherto accustomed to procurable with difficulty. We shall see the results later on. Thus, the 22nd P.N.I., when serving in 1870 in Bengal, found their accus-

(2) Regional.

tomed provisions so dear that they limited themselves to rice and dhall, and scurvy soon appeared. The 8th N.I. at Alipore also became affected with scurvy, but not throughout; the Punjabi element was the element affected, owing to the men not being able to get their accustomed food; whilst the Dogras and Hillmen of the regiment were free from it, inasmuch as on their native hills they live on rice, and thrive on it. Hence, unless Government makes provision to give up-country men free rations of meat and vegetables to which they are accustomed, they should not be brought down for campaigns where such cannot be easily obtained.

(3) Anæmia. (3) But the same indication is also urgent apart from the food question. Dr. Verchere does not hold scurvy in the native army to be entirely dependent on the native food; other elements enter in, and amongst them a climate causing anæmia. Hence, do not bring the Punjabi from his native bracing climate to the relaxing anæmic climate of Bengal for Bengal frontier expeditions.

(4) Malaria. (4) Finally, men with a malarious history are prone to become scorbutic. In addition to other instances mentioned farther on, it is found that on the Punjab frontier many of the men become scorbutic subsequent to ague. The scurvy is apt to appear in the cold weather, and is probably induced by the scarcity of vegetables in the hot weather, and the anæmic condition produced by the malarial attacks in the autumn.

Selection of Season.—Curiously diverse opinions are found regarding the relative frequency of scurvy in hot and cold climates. I believe, however, the balance of opinion is in favour of scurvy being more liable to arise in hot climates; this is easily understood, for the relaxed condition of the tissues induced by a residence in the tropics must predispose to scurvy. Of ten epidemics in tropical and sub-tropical countries, Hirsch found that one occurred only in the cold weather, four in the hot season, and five just before or after the hot season. Here again, therefore, the cold weather is to be selected.

Transports.—On board ship, especially in transports, overcrowding has acted as a predisposing cause. Let there be, therefore, the maximum of room for each soldier. For, in these instances, scurvy is most prone to attack those who pass the greater part of their time in the overcrowded lower decks.

The Camp.—Dr. Verchere and others, in the Reports of the Bengal Native Army, have shown how frequently scurvy is a sequel of malaria, and attacks especially malarious subjects when the occasion for it arises. Thus, in 1876 we find a good example of this in the 42nd Assam Light Infantry. Here a scorbutic tendency was induced by the depraved state of the blood consequent on repeated attacks of malarial fever, with their concomitant splenic and liver disorders. A vegetable diet was enforced, under which health became restored. Hence, here we learn another reason for the avoidance of sites inducing malaria. In the Bengal Army Reports for 1872 the same sequence is shown as regards the scurvy that appeared in the 10th N.I. and 37th N.I. Secondly, as shown above, let there be no over-

crowding. And, thirdly, let there be no excess of night duty, especially in malarious localities, if possible. Especial attention was drawn to the predisposing effect of excessive night duties in the production of scurvy in the Bengal Army Reports for 1872.

Food.—We next come to the important subject of food. As regards that of the native army, I shall reserve my remarks till the end of this chapter.

(1) Sufficient for the work.

First, the food must be sufficient for the work done. This is evidently necessary in order that the men may be in the best condition to resist deteriorating influences; specifically, with regard to scurvy; moreover, Krause holds this to be the essential element, inasmuch as he thinks scurvy to arise simply from a long supply of an amount of food insufficient for the work to be done. This I cannot agree with. But there is no doubt that an insufficient diet will powerfully predispose to scurvy. Thus, Hirsch relates how, in the Kaffir war of 1836, although all the regiments were in want of vegetable food equally, yet only one regiment suffered severely. This regiment, however, had to undergo very great fatigue in making long marches, and therefore the deficient diet was more severely felt.

(2) Fresh meat and vegetables.

Secondly, fresh meat and fresh vegetables should be given as far as possible. Every opportunity should be taken in small expeditions to carry live stock. This, as we have seen, was carried out in the Duffla expedition. The Bhootan war showed the baneful effects of a want of fresh vegetables. Pritchard relates that the mortality became so excessive that the attention of the authorities was attracted, and "the long-solicited vegetables were sent up, though too late to save life." During the siege of Lucknow, again, scurvy was greatly prevalent from this cause.

But it can rarely happen that fresh vegetables and meat can be supplied throughout a campaign. We must therefore,

(3) Natural vegetable products.

Thirdly, look out for the natural products of the country. For example, in the Aka expedition, wild lemons, begonia, and the elephant apple were found, and formed excellent anti-scorbutics. In Ashanti were found oranges and lemons. In New Zealand, sow-thistles and wild potatoes. Again, the dandelion and speedwell form good anti-scorbutics. In Afghanistan, in the Kurram Valley, onions were at times obtainable in their season; also potatoes. In Mexico, excellent wild vegetables were obtainable.

Should an expedition campaign on the Persian Gulf, abundance of dates would be obtained. From the description by Evatt of the resources of the Persian Gulf, there is evidently a deficiency in vegetables, yet scurvy is not mentioned as being one of the diseases of the region. Now, dates are obtainable easily. Besides being anti-scorbutic, they also are extremely nutritious. In the Sahara, for instance, "dates are not only the principal growth of the Fezzan oases, but the main subsistence of their inhabitants. All live on dates—men, women, and children, horses, asses, and camels, fowls and dogs."

(4) Lime-juice

Fourthly, the army may be reduced to salt rations and pro-

where salt provisions and preserved vegetables.

served vegetables. Now, in salted rations, the nutrient salts of the meat have passed out, and are replaced by chloride of sodium. Hence, if the men subsist long on salted provisions, scurvy is sure to appear. And with regard to dried vegetables, the process of drying weakens their anti-scorbutic properties. This was fully experienced in the War of the Secession in America. With regard to dried and compressed vegetables, it may be said that all their original properties have been lost; the albumen and salts have all been carried away by the water which is expressed from them; there remains only the framework of the tissues. Therefore it is useless to carry *compressed* vegetables. The latter, when simply dried, although with diminished anti-scorbutic power, yet have not absolutely lost their salts. Dr. Du Chaumont has shown that the ration of preserved vegetables as generally given is too small. He has shown that 7 oz. of the preserved potato are equivalent to 1 oz. of lime-juice, whereas, as a rule, the preserved vegetable ration only amounts to 2–4 oz. Hence, with such a ration always give lime-juice. Every army in the field, irrespectively of the salt or fresh nature of the provisions, should have a bi-weekly ration of lime-juice (1 oz.). This ration, too, should be given on a parade, so that it be certain that the men take it. When, however, the rations consist entirely, or nearly entirely, of preserved and salted materials, then the lime-juice must be given daily.

Compressed vegetables useless.

Besides lime-juice, pickles and vinegar should also be given. Vinegar has a high anti-scorbutic power. During the Afghan war, at its early period, a man of the mountain battery to which I was attached came into hospital with incipient scurvy. A parade was ordered that day, and several men were found in the same stage. No lime-juice was to be had in the camp, but vinegar, fortunately, was obtainable. A ration of vinegar was regularly given out on parade every day to the men of the battery, and the disease was stayed.

(5) Varied diet.

Fifthly, the diet should be varied as much as possible. A few remarks on the relative value of vegetables may be added. The potato is the anti-scorbutic *par excellence*, due to the salts (whose acids form carbonates) that it contains. These vary from 0.7 to 1.5 per cent., the most important being tartrates, citrates, and malates. Next to the potato come the yam and sweet potato, then onions, parsnips, carrots, cabbage. The anti-scorbutic value as regards salts is shown in the following table:—

Salts: Amount in Grains of 1 lb. of the following Vegetables:—

Sweet potato	203	Parsnips	70	Turnips	42
Yam	91	Carrots	70	Cabbage	42

The onion, besides being superior in anti-scorbutic power to turnips, has an essential oil, so that it also acts as a condiment.

With regard to preserved peas and beans, they are useless as anti-scorbutics, in consequence of the absence of the salts, whose value has been shown above. Their value in campaigns is simply due to the large amount of nitrogenous matter they contain.

Given with advantage in addition to vegetables, they should never be substituted for the latter.

Drinking-water. Ward.

The evidence that certain qualities of the drinking-water *per se* can cause scurvy seems very strong. The late Dr. Stephen Ward (for many years senior physician to the Seamen's Hospital, Greenwich) has thrown out the suggestion that the use of condensed water for drinking purposes acts as a predisposing cause. He submits several facts in favour of the hypothesis in his valuable work on tropical diseases. He draws attention to the fact that the scurvy appears to be at a minimum in the British mercantile marine (since the introduction of lime-juice), yet it still exists, often with its old severity, on board ships bound from Aden to other parts. Condensed water is supplied at Aden to most ships sailing from that port, owing to the notorious deficiency of the water-supply of that town. Again, Larrey, with regard to scurvy in the French army in Egypt, states that the disease only broke out when good water failed. Dr. Beckler, the medical officer to Burke's exploration in Australia, distinctly states that the very early appearance of scurvy was due to bad water, and not to deprivation of fresh vegetables. The latter appear to have been ample. The water was stagnant—in pools full of animal and vegetable life. Dr. Beckler states that it was the character of the water (or, rather, the want of fresh water) that caused the outbreak of scurvy; there was at the time it broke out no want of fresh vegetables. As an additional argument, Dr. Beckler shows that other exploring parties with the same provisions, but with good water, were not affected.

Larrey.

Beckler.

Verchere.

Dr. Verchere, of the Bengal Army, drew attention to a condition of the water which will produce scurvy. He attributed the outbreak of scurvy in the 13th N.I. to this quality. The drinking-water was impregnated with the salts of "reh," a soil containing sulphate of sodium and chloride of sodium. Water percolating through such a soil dissolves out these salts, and produces a condition of the blood analogous to that of scurvy. The soils containing these salts in abundance are formed by accumulations of river silt; such accumulations encroach on the sea in the deltas of rivers—*e.g.*, in Bengal. Through evaporation, the salts are left behind, and the whole saline constituents of millions of gallons of water are contained thus in strata a few feet thick.

Ralfe.

Hence avoid water obtained from such a source. It is probable that the water drunk in Beckler's expedition and that by the French troops in Egypt was of this description. Scurvy will appear under the use of this salted water, as it will under the use of salted provisions. Dr. Ralfe has shown that in scurvy the neutral salts, such as the chlorides, are either increased relatively at the expense of the alkaline salts, or their alkaline salts are absolutely decreased. Now, in animals where the alkalinity of the body is reduced artificially, dissolution of the blood-corpuscles, ecchymoses on the mucous surfaces, &c.—states found in scurvy—are induced. This view fully explains the action of salted provisions and salted water in inducing the disease.

1. Inspection. 2. Keep up men's spirits.

General Measures.—(1) There must be regular inspection of the regiments to detect first appearance or indication. (2) As nothing apparently predisposes to scurvy so much as depression of spirits and monotony of existence, the life of the men in the camps along the line of communication must be made as cheerful as possible. Here the excitement of the "front" is wanting. Let there be weekly gymkhanas, musical evenings, and other such resources calculated to engender the spirit of *bonhomie*. (3) Where extra fatigue is imposed on the men, extra vigilance will be required in prophylaxis. Excessive fatigue predisposes the body to the invasion of the disease.

3. Provide for extra fatigue.

Lime-juice.

Anti-scorbutic "Ration."—I have already alluded to lime-juice. I must add a few words concerning it, and also briefly allude to certain other anti-scorbutic agents not yet mentioned. With regard to lime-juice, it seems necessary to insist on its anti-scorbutic properties. In connection with the Nares expedition, Neale stated that he did not think that lime-juice was of much use. As Dr. Macdowall remarks, we shall next be asked to believe that fresh vegetables are not of much use. The 21st P.N.I. in the Abyssinian war suffered severely from scurvy. From the records of the regiments of the native army engaged in that campaign, it appears that in no other native regiment was scurvy prevalent. In most it was absent. The regiment sailed from Bombay in two transports. The men of one of these transports were those affected by scurvy chiefly, and in that transport no daily ration of lime-juice was given. Those in the second transport who had scurvy were the non-cooking men.

Again, during the time I was resident physician at the Seamen's Hospital, Greenwich, the value of lime-juice was shown to me unmistakably. Sailors used to be carried into the wards in a complete state of exhaustion; their earthy faces, enormously spongy gums, and horrible odour showed the ravages of the disease. A few days' treatment simply by lime-juice, and how changed was the scene! These cases, moreover, occurred invariably in the crews of ships in which either the captain had not served out, or the crew had not taken, lime-juice.

In the Nares expedition, scurvy broke out in the sledge parties. The officers and men who did not go with the sledge parties, however, were not affected. What was the difference? Lime-juice was issued to the latter; but there was no systematic issue of lime-juice to the former; in fact, there seems to have been no issue at all.

The late Mr. Harry Leach, whose experience as medical officer of the port of London and of physician to the Seamen's Hospital, Greenwich, entitle him to speak *ex cathedrâ*, has shown how the disease is almost extinct in the royal navy owing to the introduction of lime and lemon juice, whilst in the mercantile marine it has diminished from 70 to 80 per cent. I therefore feel it is superfluous to notice any further the loose objections made to lime-juice, and, in conclusion, I would again reiterate that lime-juice should be given out as soon as the troops enter on the

campaign. The issue should be at least bi-weekly. We should not wait till scurvy breaks out. This has been the custom in the French marine: they do not give lime-juice as a preventive ration, and consequently the results are not so good. As soon as fresh vegetables fail, or salt provisions are issued, the ration of lime-juice must be given *daily*.

During the voyage back from Abyssinia, bitartrate of potash was employed with great success in the treatment of the scurvy cases of the 21st P.N.I. I also thought favourably of it from what I saw of its action at the Seamen's Hospital. In the Red River expedition, bitartrate of potash was taken in each boat as an anti-scorbutic. Hence, "rations" of bitartrate of potash could be issued daily. Dr. Parkes suggests that it might be issued as salt at meals. Bitartrate of potash.

During the operations of war in Egypt in 1882, amchur was provided for the expeditionary force from India. Amchur is made of the dried mango. This is loaded with citrates. According to Macdowall, one drachm equals half an ounce of lime-juice. It was found a fair anti-scorbutic in Egypt, and kept the disease off. Only one case of scurvy occurred, as we have seen, and, doubtless, amchur played its part in this result. Amchur.

Messrs. Galloway and Anderson have urged the prophylactic and curative properties of phosphate of potash. "Their theory is ingenious, but not convincing." Phosphate of potash.

In the recent Nile expedition, the British Army, for the first time, I believe, in its history, was supplied with jam. Doubtless jams are anti-scorbutic, but the weight and bulk of jams might be more appropriately expended in other directions. Jams.

It has been proposed, also, to supply our men, in certain cases, with beer. This proposal is so far good in that malt liquors are decidedly anti-scorbutic, but for other reasons, unless the supply were strictly regulated, soldiers would be better without beer in hot climates. In climates like that of Afghanistan, where we have a very severe winter followed by a very hot summer, beer might be usefully supplied in the camps in the cold weather in regulated quantities. But for hot seasons, if any special liquor is taken, red wines, *par excellence*, are indicated. Malt liquors. Red wines.

Scurvy in the Native Army of India.—Having seen a considerable amount of scurvy in the native army when on service in Afghanistan, I think this portion of the subject of sufficient importance to demand somewhat special remarks. For the native soldier, once he is seized by scurvy, rapidly falls to pieces. It is the duty of Government to see that in time of peace the diet of the native soldier is of such quality as to ensure no scorbutic consequences. Once a scorbutic taint be gotten, it will affect the health of the regiment for some time.

Dr. Verchere, in treating of scurvy in the native army, lays stress on other causes than deficient and unvaried food of the Sepoy. He says the scorbutic condition can be induced— Dr. Verchere's view.

(1) By repeated attacks of malaria;

(2) By excessive night duty, during agueish years, or years of heavy rainfall;

(3) By residence in a climate producing anæmia—*e.g.*, in Bengal;

(4) By drinking-water impregnated with the salts of sodium. I entirely agree with him as regards the drinking-water. I have shown how, on Ralfe's theory, this sequence of scurvy on this state of the drinking-water can be explained. With regard to malaria, Sir Anthony Home also has drawn attention to the fact observed by him that the scorbutic diathesis very often succeeds attacks of the disease.

Diet in time of peace.

I will now deal with the diet of the native soldier in time of peace. The dieting has of late years been much improved. But, in looking through the records of the native army of Bengal, of comparatively recent years, we find scorbutic conditions rife that could have been prevented. The following examples are sufficient to show this.*

In 1868 the 6th N.I., an up-country regiment, found itself in Bhootan. The regiment was alien to this part of India, and it could not obtain the diet it was accustomed to. The men were fed on the cheaper fare of the Bengali. Scurvy appeared. In the same year one of the very finest regiments in the service, the 14th Sikhs, was stationed in Calcutta. Sikhs cannot stand the Bengal climate like Hindustanis, and require meat and an ample supply of milk to enable them to do so. Milk and meat and vegetables were found so dear in Calcutta that the men did not buy them; nor did they buy ghee or atta, but lived on the cheaper and less nutritious rice and dhall. Scurvy arose. The men were then made to purchase atta and ghee, milk and vegetables, and scurvy ceased.

The 32nd Pioneers were also stationed the same year at Buxa. They had atta, dhall, ghee, and salt, with rice every third day in lieu of atta. The men had previously, in their own country, been accustomed to meat and vegetables. During the "rains," scarcely any vegetables were obtainable at Buxa. Scurvy appeared.

In 1869 the same sequence of events arose even in a regiment whose men belonged more or less to that part of the world. There was a failure in vegetables of all kind at Buxa. The penurious habits of the men of the 41st N.I. led them to buy only the very cheapest food, such as rice and dhall. Scurvy appeared.

Again, the 22nd N.I., a Punjab regiment, serving in Bengal, on account of the dearness of provisions, limited themselves to rice and dhall. Scurvy appeared.

The 8th N.I. was a composite regiment. When stationed at Alipore, in Bengal, the Punjabi element became scorbutic from the same reasons, whilst the Dogra element, being accustomed to live on rice in their native hills, did not get scurvy.

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* This information concerning scurvy has been gathered from the Medical and Sanitary Reports of the Native Army of Bengal, the publication of which has unfortunately been discontinued since the retirement of Surgeon-General J. F. Beatson.

In 1872 the 10th N.I. got scurvy from the same underfeeding. Rice was substituted for atta, dhall seldom eaten, milk almost never, ghee still more seldom, whilst vegetables were practically never taken. The scorbutic men were then ordered to eat atta, ghee, dhall, and milk, and improvement took place.

Such are a few instances culled from the Reports of the Native Army of Bengal. Two lessons are therein strikingly inculcated: first, that up-country regiments should not be brought down to Bengal, and, secondly, that, if they are, the men should receive compensation by Government for dearness of provisions. Also that, wherever in India our Sepoys may be serving, compensation should be given in times of scarcity. Otherwise the scorbutic taint will creep in, and then, when called to the field, the men will break down.

In 1872 the difficulties inherent in the subject were forcibly pointed out by Dr. Cowie, of the 37th N.I. By this time Government was supplying certain rations to the men, for which Rs. 3.8.0 were deducted from their pay. Their ration consisted of atta, 1 seer; dhall, 1 chittak; ghee, 1 chittak; salt, ½ chittak. The men supplied their own firewood. Dr. Cowie rightly considered this diet insufficient, and suggested that the men should receive, in addition, vegetables or fruits, meat or fish, milk or dahi. Now, taking vegetables at 1 pice a day = 8 annas a month, and milk at the rate of ½ seer for four days of the week = Rs. 1 per mensem, Rs. 5 would therefore be cut monthly from the men's pay—a sum they could not afford.

In 1876 the question at length had been considered by Government, and in G.G.O. No. 1 of January 1877 additional allowances were made for food for the Sepoys. Hence there is now no excuse for any Sepoy getting scurvy in time of peace; should he be found to be saving his money and starving himself, he should be punished severely, for he has no right to render himself unfit for campaigning.

Looshai, 1872.

We have previously seen how scurvy became rife in Looshai. Here the ration granted to the native troops consisted of 1 lb. rice, 1 lb. flour, 2 chittaks dhall, 1 chittak ghee, ⅓ chittak salt. The greater portion of the Sepoys, however, were more or less accustomed to meat as a portion of their diet, and also to goor (sugar). Hence the above diet was deficient. The principal medical officer recommended an issue of meat twice a week if procurable, or an extra ration of ghee or goor when meat was not procurable, and a ration of rum to improve their health generally. The above ration was also supplied to the coolies. Now, the soldier carried 41 lb. 7 oz.—nearly as much as the coolie, who, at the end of his day's work, had only to eat and sleep, whereas the soldier was on guard. No wonder, then, that the Sepoy became an easy prey to scurvy when not only was the diet insufficient for the work, but contained no vegetables, fruit, or milk.

Scurvy in the Afghan war.

The following diet was authorized in the Afghan war for native troops:—Wheat flour or rice, 1 seer (2 lbs.); dhall, 2 chittaks

(4 oz.); ghee, 1 chittak (2 oz.); salt, $\frac{1}{3}$ chittak. In addition, it was laid down that, on payment, meat, chillies, huldee, and spices could be obtained. With regard to anti-scorbutics, as I have before shown, the responsible authority laid down, in the *Medical Précis* issued to all medical officers, that "the issue of lime-juice need not be insisted on," although it "appeared desirable that some supply of this article should accompany the troops to meet possible requirement." It would thus appear that it was held that the native troops were not deemed liable to scurvy. How such an opinion could have been formed had the histories of former campaigns and the medical reports of native regiments in peace been studied, I know not; but the results were the following:— In the European troops, as we have seen, anti-scorbutics were allowed; the result showed that there were only twenty-two admissions and no deaths from scurvy during the whole war. With the native army it was far different. In 1879, taking only the regular army, there were 347 admissions, or 20.1 per 1000; in 1880 there were 359 admissions, or 23.8 per 1000 for this disease. Again, the total number of deaths in 1879 in the native army, from scurvy, was 76; of these, 62 occurred in Afghanistan. For this admission rate and mortality I hold the ration entirely responsible; we have before seen that it was insufficient for the work done, thus eminently predisposing to scurvy, or, as some hold, actually exciting it. Secondly, there were no anti-scorbutic vegetables; and, lastly, there was no anti-scorbutic ration, for, although it was "held advisable" that some should accompany the force, none was obtainable. The first principles of the prevention of scurvy were neglected. I have already related the appearance of scurvy in the battery to which I was at first attached. At the same camp was located a second regiment of Punjabis, the men of which were accustomed to meat and vegetables. Scurvy became rife amongst them. I was a member of the committee assembled to report on the regiment. The taint of scurvy practically prevailed throughout, whilst there were 300 men, or nearly half, suffering markedly. The regiment had been rendered unfit by the disease for further immediate service.

Again, in South Afghanistan scurvy quickly appeared. The medical officer of the 15th B.C. at Vitakri sums up the position thus:—"The supply of atta was frequently of inferior quality, and musty at times; and the rations would appear to be deficient in not including some form of fresh vegetable food, as was evidenced by the appearance of scurvy in the force after it had been in the field only five months. Scarcely any fresh vegetables were obtainable in the district, and the men suffered much in consequence." It is to be hoped that such a scorbutic diet may never be issued again.

Conclusions. The following, then, are the essential facts that must be accepted with regard to the dieting of the native army:—

1. In time of peace the diet of the native army should be such as will never give rise to scurvy. It must be ever remembered that a scorbutic taint once gained by a regiment will last for

years, or, at any rate, will prejudice its health for years. The question of regulating the diet of Sepoys concerns the efficiency of the corps for years. If not maintained fit, it will break down at once on any extra strain.

2. In time of peace, up-country regiments should not be sent down to Bengal stations ; if they are sent owing to the exigencies of the service, especial precautions are necessary, to ensure a liberal and varied diet to the men without causing any pecuniary loss to them.

3. The absolute necessity of fresh meat, ghee, milk, and vegetables forming part of the Sepoy's diet is never to be lost sight of ; a liberal fatty and vegetable diet, with regular rations of meat at stated intervals, is to be held an axiom never to be departed from.

4. In seasons when vegetables are scarce, compensation should be made, so that the men may be enabled yet to buy them. Thus, in the hot season of the Punjab there is generally a difficulty in getting vegetables. This should be provided against.

5. The water-supply must be examined. Water largely impregnated with salines must be rejected.

6. The men should be punished if caught underfeeding.

7. In the field the men should be encouraged to forage for wild herbs, such as taraxacum, speedwell, &c.

8. So far from there "not being any necessity to insist on the daily issue of lime-juice" to the native army, *it cannot be too strenuously urged* that the contrary is the case.

9. In the field, vegetables, milk, and meat rations should be given to the native soldiers free of all expense. The diet of atta, dhall, ghee, and salt is insufficient; all essential vegetables and spices are omitted. Curry-powder should be issued as being both anti-scorbutic in itself from the garlic it contains and as forming part of the usual food of the natives.

10. Rice is never to be given as a continuous substitute for wheaten flour. Rice is extremely poor in nitrogenous matter, fats, and salts, and compares most unfavourably, as regards these respects, with wheat. Thus, according to Payen, the following are the respective ratios per cent. :—

	Rice.	Wheat.
Nitrogen	7.55	14.45
Fat	0.80	1.25
Salts	0.90	1.60

11. The experience of many surgeons of native regiments has led them to suggest a rum ration as an adjuvant to keep off scurvy. I myself have not observed this prophylactic action.

12. As far as possible vary the diet. A monotonous diet predisposes to scurvy on service.

13. If Government will only supply meat on payment to native soldiers when on service, it should cause such arrangements to be made as shall ensure the men being able to purchase the meat. In the Kurram Valley this was not generally the case.

As an example of a good diet, anti-scorbutic and otherwise, I Examples of diets.

would bring forward the following, which was recommended for the 18th Bengal Cavalry by my friend Surgeon-Major G. Griffith in the Kurram Valley:—

A. For Hindoo and Sikh Sowars.

Atta	2 lb. daily (*rice* instead of atta *twice a week*).
Dhall	4 oz. daily.
Ghee	2 oz. ,,
Milk	1 lb. ,,
Meat	2 lb. twice a week.
Dahi (curdled sour milk) .	8 oz. occasionally.
Vegetables	8 oz. three times a week.
Parched grain and every kind of fruit	Frequently.
Tea	In cold weather.
Wine or rum	1 measure four times a week.
Spices and salt . . .	As required.

B. For Mahomedan Sowars.

Ghee	2 oz. daily.
Atta	$1\frac{1}{2}$ lb. ,,
Meat	4 oz. ,,
Dahi	8 oz. ,,
Milk, instead of dahi . .	1 lb. ,,
Vegetables	8 oz. four times a week.
Fruits	Twice a week.
Rice instead of atta . .	,, ,,
Dhall	Four times a week.
Tea	In cold weather.
Spices and salts . . .	As required.

C. *On Service.*—For Hindoos and Musalmans alike.

Atta	2 lb. daily.
Dhall	4 oz. ,,
Ghee	2 oz. ,,
Salt	$\frac{1}{3}$ chittak daily (2 drachms).
Vegetables	8 oz. twice a week.
Tea	2 oz. ,, ,,
Rum	4 oz. ,, ,, (for Hindoos and Sikhs only).
Rice	2 lb. once a week instead of atta.
Goor	2 oz.

The only changes I would suggest are the following:—The issue of rum or wine four times a week is unnecessary; whilst on service an issue of meat at least twice a week should be arranged for.

Egypt.

Government, however, has at length itself seen the necessity of giving a ration of vegetables and meat to the native soldier in the field. Thus, the ration laid down for the Indian contingent in the operations of war in Egypt in 1882 contained, besides the ghee, salt, dhall, and rice of the old diets, such constituents as sugar, garlic, onions, or potatoes daily, with fresh mutton every third day.

Conclusion.

The words of Parkes may now aptly close this chapter. This eminent authority states that to prevent scurvy in any campaign is to lessen the severity of all other diseases incidental to it.

APPENDIX.—THE FOOD OF ICELANDERS.

It having been stated that scurvy is absent in Iceland notwithstanding that the inhabitants have no vegetables, and this fact (?) having been brought forward as an argument for the prophylactic powers of fresh meat against scurvy, I quote the following from Pavy's *Treatise on Food*:—

"The diet of the Icelanders consists almost solely of animal food; of bread and every other vegetable there is the utmost scarcity, and among the lower classes almost an entire privation. As an effect of these circumstances, cutaneous diseases are exceedingly frequent. Scurvy and leprosy are common. Scurvy is observed to occur with greatest frequency at those periods when there has been a deficiency of food amongst the inhabitants. *For its cure a vegetable diet is employed* in as far as the circumstances of the Icelanders will allow of such means. Fruits of every kind are altogether wanting to them, but some advantage is derived from the employment of the cochlearia, of the trefoil, of the berries and tops of the junipers, and of the sedum arce, plants which are all indigenous in the island" (Mackenzie's *Travels in Iceland*, quoted by Dr. Pavy, *Treatise on Food*, 1st edit. p. 429).

CHAPTER V.

ENTERIC FEVER.

A CONSIDERABLE amount of mental confusion has of late been brought on the young army surgeon with regard to enteric fever which I venture to think totally uncalled for. We are bidden by certain Indian pathologists to regard an increasing circle of acute diseases as caused by "climate." Thus cholera is due to "climate and other causes;" epidemics of small-pox are hinted at as being caused by "climate;" whilst, finally, Sir Joseph Fayrer, having collected a series of opinions, some of which seem not exactly congruous to the conclusions, elaborated the whole into the Croonian Lectures of 1882 as a proof that enteric fever in hot climates is due "to climate and a variety of aërial and telluric conditions" rather than to the specific causes held in Europe. Now, in contrast with the bacterial origin of acute diseases, the "climatic" origin is thus distinguished: first, no proof, experimental or otherwise, has yet been adduced to support its truth; and, secondly, the nature of the climate causing such different diseases has been left undefined and non-differentiated.

Since the appearance, however, of the Croonian Lectures of Sir J. Fayrer, a classic has appeared on which the Medical Staff is to be congratulated. I allude to the monograph on enteric fever by Surgeon-Major Welch. This work admirably exposes the fallacies of the climatic theory.

Enteric Fever in Hot Climates.—In judging of the causation of enteric fever we are met by a difficulty at the outset. In times of peace in India, for instance, the returns have been vitiated to a great extent by the personal views of those in authority. For instance, not many years ago, in one of the presidencies, all medical officers were hindered from returning any cases of enteric fever, inasmuch as the principal medical officer of that presidency held that such a disease as enteric fever did not exist in India. The contrary turn of mind has also been illustrated, for under another principal medical officer all cases of fever in which, at the post-mortem, "ulceration" of the bowels was found were ordered to be returned as cases of enteric fever. Again, in campaigns, as we shall presently see, there have been, as a rule, no definite returns for enteric fever. Thus the amount of enteric fever that has occurred in hot climates, whether in peace or war, is at present somewhat indeterminate. At the outset, I at once state that I believe nothing is more

certain than that enteric fever owns the same etiology in warm and hot climates as it does at home.*

We have said it is impossible to gather the precise extent that enteric fever has played in tropical campaigns. In the medical histories of tropical campaigns in the A.M.D. Reports up to the time of the Nile expedition I have been able to find but one campaign in which a separate return for enteric fever has been made. We know, however, that it has been severely present. But there is, as a matter of fact, no separate return for enteric fever in the Chinese (1860), Abyssinian (1867), Looshai (1871), Ashanti (1873), Sunjhie-ujong and Malay (1874, 1875, 1876), Afghan (1878–80), Zulu (1879), Natal and Transvaal (1880), or Egyptian wars (1882). All "fevers," as a rule, have been returned generally either as "fevers" or "malarial fevers." The only campaigns in which the question is entered into at all are the New Zealand, Zululand, and Egypt. In the account of the Egyptian operations of war, however, an advance was made. For the nosological return for the force from England divided fevers into "continued" and "paroxysmal;" whilst Dr. Colvin Smith furnished an ideal return for the Indian expeditionary force—viz., of "febricula," "malarial," and "enteric."

Extent of enteric fever in tropical campaigns.

Certainly the statistician can claim authority for the vague returns I am protesting against. For instance, Surgeon-Major Lyons, in his work on "relapsing fever" in India, aptly styles the "statistics from fever in 1869" given by authority "as a pilao of deaths from all fevers;" whilst the manner in which another writer handles the subject is shown by the following comment on the quoted death rate from fevers in the Thirteenth Annual Report for 1880 of the Sanitary Commissioners of the North-West Provinces. In this Report we read: "Fevers—total deaths, 987,220." But Sir Joseph Fayrer thus comments: "Nearly a million of people died in 1880 of malarial diseases." He thus interprets all "fevers" as malarial for that year.

In future, we must classify fevers as Dr. Colvin Smith has done, and as the Americans, French, and Germans do. We shall then obtain definite results to work on. Enteric fever returns are not so unimportant as to merit being hidden away in a common return of fevers. How much more definite are the French returns which enabled Virchow to show that "of the 12,253 cases that were fatal in the late French war, more than one-half succumbed to abdominal typhus—viz., 6965"! Virchow,

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* It is true I formerly held that this was not the case. I had suffered from sunstroke on service, and was invalided to England as the result. By my invaliding board, however, the diagnosis of the surgeon who attended me was not confirmed, and I was held to have suffered from enteric fever. As I had taken every precaution against the latter disease, I could only conclude that it arose according to the climatic theory. But on further investigation with the surgeon who attended me, I am convinced that the diagnosis of enteric fever was erroneous. Hence this case and further subsequent experience have convinced me that climatic causes have but a phantom existence in the causation of enteric fever.

again, is able to show, from the German Army Returns, "that there are in the main three diseases which require consideration —diphtheria, enteric fever, and dysentery," and from a further consideration of the figures he shows that "abdominal typhus is the only one of great importance, by reason of its signal influence on mortality." Finally, the statistics of the secession war of America showed in a tangible manner the ratio of enteric, for in the first year there are 21,977 cases, with 5608 deaths, tabulated; in the second year, 31,874 cases, with 10,467 deaths. But a further revision showed, indeed, a more extensive prevalence of enteric fever. As this is most important for us, inasmuch as it shows the great devastation that can be caused by enteric, I quote it in full. From the preliminary Report on the medical and surgical history of the Rebellion (Philad., 1865, p. 109, quoted by Hirsch), we find that in 1862–3 there occurred in the Atlantic region (including the coast belt between the Alleghany and the sea from New England down to Florida), in a force of 460,000, the large number of 29,666 cases of typhoid, with 7092 deaths; whilst in the central region (the Mississippi Valley between the Alleghanies and the Rocky Mountains), in a force of 403,000, there were 23,530 cases, with 8970 deaths; and finally, in the Pacific region (Oregon and California), out of 15,408, there were only 155 cases, with 13 deaths. The respective rates were therefore

	Admissions.		Deaths.
In the Atlantic region . .	64.2 per 1000	...	15.4 per 1000
,, Central ,, . .	58.4 ,,	...	22.3 ,,

In this calculation, again, no account is taken of 12,093 cases of typho-malarial fever, with 487 deaths, which are in the Reports for the Atlantic region. Here, then, we have an example, not only useful to us, for many of the regions included in the war were sub-tropical, but also one that should be followed in statistical arrangement in the future.

There can be no doubt, then, that enteric fever does play a large part in campaigns in hot climates, and that the geographical distribution of the disease shows that its "incidence is as wide as the globe, and disposes of the opinion, which had been widely accepted until quite recent times, that the tropics enjoy a complete immunity from it." But now recent times show that, so far from there being complete immunity in the tropics, the frequency of enteric in these regions is held so great that it is held by some as only explicable under "climate." But in like manner as Hirsch demonstrated that "the climate does *not, in and by itself*, exert any determining influence" on the then *supposed* rarity of the disease in the tropics, so now I propose to show also that "the climate does *not, in and by itself*, exert any determining influence" on the *supposed* frequency of the disease in the tropics.

To ensure this, and to obtain a scientific and thorough basis for the prevention of the disease in tropical campaigns, it will be necessary to examine somewhat in detail the various views that

have been held as to its occurrence in the tropics. The following are, then, these various views :—

Views of Etiology of Enteric Fever in the Tropics.

1. The climatic theory.
2. The "other cause," or "conglomerate," theory (Fayrer).
3. The self-empoisonment theory (Stich).
4. The theory of Surgeon-General Moore.
5. The vicarious theory (Martin).
6. The transformation theory (Colin).
7. The pythogenic theory.
8. The specific theory.

I will at once state that, according to my experience, the etiology of enteric fever is the same in hot climates as in England, and that of the two theories—the specific and pythogenic—I believe the specific to be correct. At the same time, by acting also on the pythogenic view, the specific causation will be also prevented.

1. **The Climatic.**—In order to dissipate the climatic theory, let us see what it states. The theory is that "climatic influences, acting on young and undeveloped constitutions predisposed in some way specially to develop typhoid, may start the disease" (Clarke, quoted by Fayrer); that "typhoid fever in the British soldier in India is primarily due to climatic influences" (Bryden); that it may have a "malarious origin;" that "it is due to (1) predisposition, (2) age, (3) want of acclimatization (Dr. Don). It may be summarily stated, from these and similar opinions compiled in Sir J. Fayrer's work, that the theory in question seeks to find a primary causation for enteric fever in India, and tropical and sub-tropical climates, in "*climatic*" agencies acting on *young soldiers recently arrived.* With this is interwoven the influence of "atmospheric waves" of other writers. Such a theory presents to the sanitarian a hopeless and impregnable front, for with the short-service system, together with the liability of service greatest in tropical and sub-tropical climates, it will be impossible to prevent the disease, especially as we all know that enteric fever attacks by preference the young and robust—in fact, just the class of men composing our troops. It is therefore of vital importance for the benefit of the soldier that this theory be demolished. It will be seen that the theory is eminently, but superficially, comprehensive. We must first eliminate some of the elements. To take first the least valuable. The "meteorological" etiology that is so persistently brought forward by certain writers is but another name for ignorance : "epidemic constitution," says Billings, a distinguished surgeon of the U.S. army, "merely is another phrase for want of knowledge" in connection with this etiology of typhoid. Truly did the late Prof. Parkes well describe such causation as "the mythical region of epidemic distribution." What idea can possibly be conveyed to the human mind by the assertion that "typhoid, everywhere, is of atmospheric, and, probably, of epidemic origin, in India, and due to atmospheric waves." As

The factor of the genius epidemicus

Prof. Maclean truly retorted, when he was a student at Edinburgh typh*us* fever raged at Edinburgh, but its absence now was not due to the absence of the "atmospheric wave," but to "improved sanitation." And so it will be found is the case with enteric fever in the tropics as well as in temperate climes.

The factor of erroneous diagnosis.

Secondly, it must, of a truth, be acknowledged that a great many cases of enteric fever are diagnosed in the tropics where no enteric fever exists. We have before alluded to the factor of the enforced official returns, in this respect. The idea of returning all cases of fever in which, at the post-mortem, ulceration of the intestines is found, will no doubt increase the returns for enteric fever, and will also show enteric fever to have arisen on inexplicable grounds; but the conclusion therefrom that enteric fever in hot climates arises from "climate" unfortunately rests on the false premiss that cases returned as enteric fever are not enteric fever at all. The argument, indeed, expressed in terms of the syllogism, runs thus:—All cases of fever with ulceration of the intestines are enteric fever. Cases of fever with ulceration of the intestines are caused by climate. Hence cases of enteric fever are caused by climate. But those who are acquainted with the rules of logic will at once recognize herein an example of the fallacy of the undistributed middle. Dr. Wall has so completely put the whole question in a nutshell that I cannot forbear quoting him: "I believe that a large proportion of cases returned as typhoid fever have no right to that name. If a man die in India after having an elevated temperature, and an ulcer be found in his intestine, the case is at once called typhoid. But it takes a great deal more than an intestinal ulcer to make a typhoid fever. I have seen many cases that could not with certainty be referred to any type of fever, but which had, on the whole, more resemblance to remittent than any other, and which were found after death to be coincident with intestinal ulceration, *but an ulceration distinctly not typhoid.* It was an irregular ulceration, by no means selecting the site of Peyer's patches, and very often encircling the intestines; and my experience is that this form of ulceration often occurs in cases that would better bear the name 'remittent' than anything else." The presence of ulcers in the small intestine in patients dying of fever has been constantly remarked on by different observers. Annesley, Twining, and Ranald Martin draw attention to it. Surgeon-Major Edge, in the Zulu war, found it, and differentiated it from the ulceration of enteric fever. It cannot be too definitely laid down that "ulceration" is, in the first place, not the proper expression to apply to the process in the intestine in typhoid fever, for it does not express the whole process; and, secondly, to be pathognomic it must occur in the pathognomic site, and no other, of enteric fever. This site is constituted by Peyer's patches and the solitary glands. As it is, fever with the "typhoid state" has been confounded with typhoid fever; "enteric fever" has been mixed up with "fever with enteric symptoms".

and "fever lapsing into the typhoid state." With respect to this question of diagnosis, Surgeon-Major Myers, at a meeting of the Med. Chir. Society on February 9, 1886, stated that, when in Egypt, he felt doubtful, from what he had seen, whether many cases were true enteric fever at all, and pertinently asked what had been the post-mortem appearances of Peyer's patches. In connection also with diagnosis, I would draw attention to the last published lecture of Dr. Murchison, who combined European with Indian experience. In a paper on the various forms of intermitting pyrexia, Dr. Murchison drew attention to certain cases of enteric fever—marked by certain peculiarities impressed on them in the tropics, viz., (*a*) a set of cases commencing with all the phenomena of ague, and with two or more attacks of rigor followed by sweating; and (*b*) a set of cases presenting an intermitting character throughout. M. V. Frison, again, has drawn attention to the fact that enteric fever may commence with a remittent or intermittent type of fever. Allusion to these cases will be found from my experience in the chapter on Typho-malarial Fever; meanwhile, they are here indicated as showing how, in the matter of diagnosis, enteric fever may be commonly modified in the tropics. Lastly, we would point out that ordinary simple diarrhœa in the tropics is often accompanied by a high temperature. Thus, not only is enteric fever modified by a tropical climate as regards its symptoms, but it has also to be diagnosed from cases of fever with diarrhœa and remittent fever lapsing into the typhoid state; and this is just what has not been done, I believe, in a great many instances. The recent observations of Dr. Vandyke Carter, of Bombay, tend still further to throw light on the subject of intestinal ulceration in India. He has described an apparently new form of Peyerian ulcer lesion, manifestly different from that of genuine typhoid fever. All his eleven examples occurred in *adults*, some of whom were, however, recent immigrants. The ulceration was manifold in the jejunum and ileum, by preference involving the areas of Peyer's patches. But the ulcers were not so Peyerian as in enteric fever; of smaller size; the slough was far scantier, and usually absent; there was not the prime feature of the true enteric lesion, viz., a copious cell proliferation; whilst the lesion itself supervenes, not early in the beginning, as in enteric fever, but as a late, superadded phenomenon. The mesenteric glands are less affected and not nearly so strikingly. No modification of the true enteric fever lesion could wholly resemble these. As regards the etiology, Dr. Carter can only surmise the operation of a "septic" influence different from the "typhoid." Many other points of difference from typhoid fever are given in Dr. Carter's work, which is certainly one of the most valuable reports on the subject, and will go far to dissipate the confusion attending enteric fever in India, and to secure a more exact diagnosis.

Dr. Vandyke Carter's researches.

We now come to the discussion of the climatic theory. It is gravely stated that the specific or pythogenic theories of the origin of enteric fever will not account for the proclivity of young

soldiers recently arrived in tropical or sub-tropical climates, but that there is something in the "climate" which acts as the exciting factor, combined with "youth" and "recent arrival," inasmuch as "the facts are not covered by the explanation of the origin of enteric as accepted in England" (Fayrer). Sir J. Fayrer also states "that there is more evidence that ordinary climatic fever may assume the typhoid, *i.e.*, the enteric, condition, than that all enteric fever is caused by fæcal contamination." The pathology of this sentence is a little difficult, but I presume that "the enteric condition" is a term used for the condition found in enteric fever. Now, the "typhoid condition," as I have before pointed out, is not the condition found especially in typhoid or enteric fever. Any fever, specific or simple, can lapse into the typhoid condition. Again, what is "ordinary climatic fever"? I presume it must be either simple continued fever or malarial fever. If so, we have here another theory mingled with the climatic theory, viz., the theory of Colin, of which more anon. Let us, however, first consider the collated factors of youth, recent arrival, and a hot climate.

(1) **Youth.**—Andral made the observation that young medical students were most likely to be attacked with enteric fever within a few days of their arrival in Paris. He forbore, however, to state that there was something in the "climate" of Paris especially causing enteric fever in young, recently arrived medical students. Youth everywhere predisposes to enteric fever; the glands of Peyer are then at the height of their functional activity; but can it be asserted that youth in a hot climate is affected in a greater degree than in a cold climate? That is the question for the climatic theorists to answer.

Murchison's statistics.

The mean age of 1772 cases admitted into the London Fever Hospital during ten years was 21.25 (Murchison). Murchison's tables show the numbers admitted in each quinquennium :—

	Percentage of Cases.
Under 5 years	0.98
From 5–9 ,,	9.44
,, 10–14 ,,	18.16
,, 15–19 ,,	26.86
,, 20–24 ,,	19.69
,, 25–29 ,,	10.15

From this table it appears that nearly one-half (46.55 per cent.) of the cases were between fifteen and twenty-five years of age, and less than one-seventh (13.8 per cent.) were above thirty.

Liebermeister.

The statistics of Liebermeister show the relation of age as a factor of the whole number of typhoid fever cases admitted into the Basle Hospital from 1865 to 1870. The first column gives the simple number of cases; the second, the percentage of cases for each class; the third, the percentage of the entire population which the numbers belonging to each age represents; and the fourth, the predisposition of each age :—

Age.	Number of Patients.	Percentage of all the Cases.	Percentage of Population of each Age in the entire Population.	Disposition of each Age compared to Average = 1.
16–20	323	19.0	12	1.6
21–30	987	58.0	29	2.0
31–40	294	16.0	24	0.7
41–50	88	5.0	16	0.3
51–60	30	2.0	10	0.2
61–70	11	0.6	6	0.1

The latest statistics are those given by Dr. Collie, based on 3523 cases of enteric fever in three fever hospitals:— Collie's statistics.

Age.	Percentage of Enteric Fever.
10–14	22.60
15–19	25.00
20–24	26.80
25–29	9.75

Let us now examine any statistics of enteric fever as regards age in hot climates. Unfortunately, we have none that have been calculated at corresponding periods of life to offer, nor have they been calculated in the same way; but, nevertheless, they do not show a greater frequency as regards India. Thus, in the report of the principal medical officer for 1878, concerning the prevalence of enteric fever amongst the European troops in India, the following is the rate for the Bengal command:— Bengal army statistics.

Age.	Per 1000 of Strength.	Age.	Per 1000 of Strength.
22 and under	33.17 cases	26–28	6.73
22–24	18.68 ,,	28–30	2.58
24–26	13.11 ,,	Above 30	2.41

Now this table simply shows what the European tables show—viz., the marked susceptibility to enteric fever of the young individual up to twenty-five years of age. But it does not show anything more. The factor of predisposition up to this age is a general factor common to both hot and cold climates. But these latter statistics were brought forward by Marston to show "the proclivity of the newly arrived soldier." They really simply show the proclivity of *the age* at which the newly arrived soldier has attained. It must be borne in mind that our soldiers at the age they arrive in India actually constitute such a body of men as would be selected at home as the most predisposed body of individuals for an attack by enteric fever by an experimenter *in corpore vili*. As Welch tersely puts it, "the chief age susceptibility concurs with recency of arrival in India." The marked susceptibility of the young soldier to enteric is seen in India as elsewhere. What the advocates of the "climatic theory" have to show by statistics is, that the relative susceptibility of the period 19–25 years is greater in young soldiers in hot climates than in cold. Nay, more—to show the influence of climate on enteric fever they should show that new arrivals of an age *above that most predisposed to enteric* suffer more than those of a corresponding age in England; and these facts they have not done. As Dr. Maclean well

Marston. Welch. Professor Maclean.

puts it, all soldiers sent to India are just those whose age corresponds to the period when enteric is most rife; but enteric in India is caused by the same factor as in England—viz., decomposed nitrogenous matter. Again, Surgeon-General Mouatt, V.C., as the result of his large experience, distinctly states that young soldiers in India are no more liable to enteric fever than young soldiers in Europe; whilst, finally, Dr. Wilson, of Philadelphia, in his *Treatise on Continued Fevers,* shows that there is nothing peculiar regarding the factor of age in hot climates.

Surgeon-General Mouatt, V.C.

Dr. Wilson.

(2) **Recent Arrival.**—We next proceed to show that there is nothing especial in the factor of recent arrival in a hot country. Recent arrival is by all authorities noted as a predisposing cause for enteric fever, but it does not predispose to any greater degree in hot than in temperate climates. Let us look at figures. Louis gives for civil life 129 cases, of which 73 had not resided in Paris more than ten months, and 102 not more than twenty months; Chomel, 92 cases, of which 1 had resided in Paris only a year or less. Again, in military life, we find that in the Prussian army from 1867 to 1879, in the first year of service, there died 44.3 per cent. of all the cases of enteric fever deaths; in the second year, 33 per cent.; in the third year, 14 per cent.; and in all the remaining years together only 8 per cent. In the French army from 1864 to 1866, in the first year of service, the mortality from enteric fever was 4.37 per cent.; in the second and third years, 4.22 per cent.; in the fourth and fifth years, 1.85 per cent.; in the sixth and seventh years, 1.24 per cent., and so on, progressively diminishing. In the English army at home we find the same facts. Thus, in the Kinsale outbreak, in 1875, among twenty-one cases the service periods were—

Louis.

Chomel.

Prussian army.

French army.

English army at home.

Under 1 year's service	8 cases
Between 1 and 2 years' ,, ...	5 ,,
,, 2 ,, 3 ,, ,, ...	3 ,,
,, 3 ,, 4 ,, ,, ...	1 ,,
,, 4 ,, 5 ,, ,, ...	1 ,,
,, 6 ,, 7 ,, ,, ...	1 ,,

We here take years of service as practically equivalent to recent arrival. Now, on comparing these facts with similar facts in India, we find the factor of recent arrival in India predisposes to enteric fever, but not more so than recent arrival in a temperate station. As Dr. Welch states, the service ratios adduced for India are on a par with those for the Kinsale outbreak. In the same report for 1878 (already referred to as regards age) we find the influence of service in India thus shown:—

Continuous Residence in India.	Per 1000 of Strength.	
	Cases.	Deaths.
1 year and under . . .	34.39	13.35
2 years ,, ...	16.60	6.20
3 ,, ,, ...	7.19	3.16
4 ,, ,, ...	11.32	5.50
5 ,, ,, ...	6.39	2.79
Above 5 years . . .	2.65	1.32

Now, can any one hold, from all these statistics, that recent arrival in India predisposes more than recent arrival in any place in a temperate climate? But more. Dr. Marston quotes this table to prove that our soldiers are especially liable to enteric in their first years of service in India. Now, evidently, the facts of the fourth year, as compared with those of the third, do not support this especial view. To get over them Marston remarks the ratio "is probably accidental." But, on the supposition that Marston's climatic theory is correct, why should not the numbers of the first and second and third years be equally "accidental" as those of the fourth?

(3) **Climate.**—I finally come to the great third supposed factor—viz., climate, the influence of the sub-tropical and tropical climate. I have shown, as regards *age* and *recent arrival*, that the statement that there is "a proclivity to enteric fever in hot climates in European young soldiers such as European theories will not account for," is in fact not founded on fact. I will show the equally sandy ground on which the theory of "climate" has been built.

Take first *sub-tropical* stations. As regards the Cape, for instance, Dr. Welch shows how variable have been the returns in succeeding years. There are even years of intermittence, when there have been no returns at all. Now this variability in the returns with a constant climate, is absolutely antagonistic to climate as a primary etiological factor. Gibraltar and Malta returns show the same results. There is not only marked variability in the return for enteric in the different corps of the garrison, but also in the different segments of the same corps. And yet withal, we have the same climatic influence over all. Dr. Welch indeed, shows that the climate and general conditions existing on these stations do exert a prejudicial influence on new comers, but it is only as regards "seasoning" disease, febricula, rock diarrhœa, and fever, &c., but *not as regards enteric fever* cases, which, in Gibraltar and Malta, are few and exceptional, especially when we consider the numbers are constantly changing, and fresh arrivals of the susceptible age are constantly coming. This shows that something more than age influence, recent arrival, and climatic causes, is necessary to produce enteric fever.

And now if we turn *to the tropics* and *India*, we find, in the first place, how wide is the geographical range. In South America, for instance, it is found from the sea-coast to the snow line (Hirsch). In India it is as capable of flourishing in the hills as in the hot plains. Under the term "climate," as Scott remarks in his work on meteorology, is understood the combined effect of all the various phenomena embraced by meteorology, "and which determined the suitability of various districts for the support of their respective fauna and flora. Beyond all doubt, the most important factor in these determinations is the *temperature*."

The law of decrement of heat with ascent above the sea level, will render intelligible the statement of Herschel, "that in ascending a mountain from the sea-level to the limit of perpetual

snow, we pass through the same series of climates, so far as temperature is concerned, which we should do by travelling from the same station to the polar regions of the globe; and in a country where very great differences of level exist, we find every variety of climate arranged in zones according to the altitude, and characterized by the vegetable productions appropriate to their habitual temperatures." Now, according to the "climatic" theory, we are forced to conclude that at some altitude the etiology of enteric fever must suddenly alter. Parkes shows that, for India, an ascent of 5000 or 6000 feet reduces the temperature to the English mean. Are we to suppose that, on the lower side of a given altitudinal line, enteric fever is due to age, recent arrival, and hot climate, and on the upper side is due to a pythogenic or specific cause? In the march of Cortez to Mexico, over the Cordilleras, "a single day's journey would convey the force through the climates of several degrees of latitude," thus we see that enteric fever breaking out in such a march would own different causation at different periods of the march. This is reducing pathology to a farce. Again, we here find *the same variability* in the returns for enteric, as we have previously noted in sub-tropical climates. The enteric fever returns for any one station are not uniform, as they should be, if the disease be due to climate. *Variability is the rule.* Let us again quote from Dr. Welch. "Bareilly has given the highest ratio for any one year, ordinarily one of the healthiest of the plain stations in Bengal; next is Sabathu, in the hills, and next Cananore, on the sea-coast, the ratio being per 1000 of strength, 72.5, 57.2, and 47.4: the three highest stations in individual years for the period* representing variations of climate in Indian stations. It may be asked what is there in common in climate between any plain station, the sea-coast, and the hills, to form the necessary factor for the enteric fever which exists and flourishes in one as the other?" In fact, as Brigade-Surgeon Chapple says on this question, *If climate be the cause, define the nature of the climate?* This is a question that has, up to date, received no answer from Sir J. Fayrer, Drs. Gordon, Grabham, and others, who have patronized this view. I repeat, that in India enteric fever is found under all conditions of its diversities of climate, in very hot and very dry localities, in very cold stations, in the hills, and in the plains, in different ratios in different regiments, at one and the same time located in any given station; in different ratios in different years under exactly the same conditions of climate; and if climate be the cause of enteric fever, let its advocate define the nature of it. For instance, let some authority tell us in what peculiar way temperature, rainfall, air-pressure, air-moisture, dew, fog, mist, clouds, wind, electrical, astronomical, telluric, or cyclonic phenomena can cause enteric fever severally or collectively. The temperature element of climate is clearly shown by Hirsch, at any rate, to have no special connection with its

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* A period of seven years ending 1878.

origin, for, as he shows, the acme of the diseases falls variously in different regions within higher latitudes, either in autumn or in winter, whilst in the tropics it falls mostly at the time of the greatest heats.

Conclusions regarding "climatic origin.

To think that climatic causes can generate enteric fever is just as reasonable as to think that they can generate plants and animals. The specific seed is equally necessary for both. But the most ludicrous part of this etiology is that the same factor, "climate," was formerly evoked to account for the immunity of India, in the days when it was held that enteric fever did not exist in India. It was stated that India and the tropics enjoyed a complete immunity from it. Hirsch even appears still to hold the view of this immunity, but he, nevertheless, expends some sections on the subject to prove that "in all this we have evidence that the climate does not, in and by itself, exert a determining influence on the occurrence of typhoid, and that the reason of the comparative rarity of the disease in the tropics must be attributed, therefore, to other circumstances." And, granting that "climate" be a cause, how hopeless is our preventive treatment. Our soldiers would not have a chance. The only way we could combat the disease, in fact, in hot climates, would be to select an army of middle-aged (or, even better, of aged), debilitated (for enteric attacks the robust by preference) men who have resided for a length of time in the tropics.*

Summary.

To sum up, I would reiterate that the chief age susceptibility of enteric fever concurs with the recent arrival period of our troops in India, or, in other words, that it is just the first year's service of our troops in India that coincides with the general age of susceptibility. This, combined with the general predisposition of recent sojourn in any infected locality in any zone, explains fully why our young soldiers in India get enteric. We say "*any infected locality*," be it observed : therein lies the cause of the enteric attack ; not in the climate. The increasing return of enteric are, moreover, due to increasing accuracy of diagnosis. If all cases, moreover, of fatal "fever," in which any ulceration whatever of the intestines is found, are to be returned as cases of "enteric fever," of course the returns will be greater, and enteric fever be shown to be increasing in India amongst our young soldiers.

Real effect of hot climates.

But although a tropical or sub-tropical climate has no influence as a primary exciting cause of enteric, yet when once the disease

* The remarks of Dr. Welch on the Straits Settlements are very apposite, and will repay quotation : "We here find a climate which embraces in a marked degree tropical features. We find troops quartered here fresh from England, the Cape, &c.—the 80th Regiment especially, from Ireland, with very many young soldiers in the ranks—material thoroughly adapted to test existent conditions as capable of producing enteric fever. We find paroxysmal fevers and simple continued fevers referred to climate ; diarrhœa and dysentery referred to drinking water undoubtedly fæcally contaminated during the Perak war ; yet in several years enteric fever was absent, and in no one did it constitute but an insignificant fraction of the sickness and mortality.

has originated, the influence of the climate will be shown in the higher death-rate. The death-rate from enteric fever in warm countries is higher than that in temperate. Nor is this to be wondered at. For, on coming out to hot climates, the system of the British soldier is exposed to a new life. There is increased activity in any acute fever, due to the diminished resistant power of the patient. It is evident that, *cæteris paribus*, a man with enteric fever in a temperate climate will have a better chance than a man with enteric fever in a hot climate. Moreover, we may theoretically imagine that the specific organism of enteric will have greater powers in a hot climate than in a cold; or, if one takes the pythogenic theory, that the putrefaction processes and fæcal poisoning will be relatively of greater virulence in hot than temperate regions. Again, as Marston shows, the average expectation of life diminishes in hot countries as at home in proportion to age, only in a far higher ratio. Hence, a larger number of soldiers will die from enteric fever. So much, then, for the climatic theory.

2. **The "Other Cause" or "Conglomerate" Theory.**—The "other cause," or "conglomerate" theory of Sir Joseph Fayrer is in part related to the "climatic theory"; but it is far more comprehensive. I have termed this theory the "conglomerate" theory, on account of the comprehensive basis of its etiology. How great is its comprehension is evident from the following definition of its author: "To attribute all cases of enteric fever to fæcal poisoning is erroneous and dangerous; that geographical position and climatic influences, heat, moisture, organic decomposition, miasmata, and a variety of aërial and telluric conditions are more likely than a specific cause in India." In the collection of opinions forming the basis of the theory, we find scarcely any definite post-mortem accounts; cases are described which I consider to be utterly irrelevant to the point at issue; whilst, finally, there is an absence of proof that the cases brought forward to illustrate it were not due to a specific or pythogenic cause. From an examination of the cases, the argument reduced to logical expression is the following:—Cases of ulceration of the intestine are caused, in warm climates, by a variety of aërial and telluric conditions. But enteric fever is accompanied by ulceration of the intestine. Therefore, enteric fever is caused by a variety of aërial and telluric conditions. Finally, Sir Joseph Fayrer himself condemns his whole superstructure, for he proposes to call this variety of enteric fever, "endemic" enteric fever, as distinguished from the "specific" enteric fever. But *all enteric fever, as we know, is essentially endemic.* Enteric fever, as Murchison remarks, is *the* endemic fever of England, as it is of France and of America. It is a peculiarity of this disease that it is endemic everywhere. Two conditions are necessary for "climatic" and "other cause" theorists to demonstrate as existing before they can establish these peculiar doctrines on a scientific basis. The first is, that the fever in question in any given case is actually enteric fever; the second is, that all specific or pathogenic causa-

tion is absolutely excluded. But at present these two conditions often have not been established. As we shall presently see, the conditions for enteric fever are luxuriant in warm countries, especially on the pythogenic etiology.

Before leaving this theory, I notice that Sir J. Fayrer has also placed on record that not only is it erroneous to attribute all cases of enteric fever to the European pathology, but that it *is also dangerous.* Why dangerous? I reply that it is far more dangerous to shut one's eyes to the pythogenic and specific causation, for we shall have nothing definite then to work on.

3. **The Self-Empoisonment Theory.**—The self-empoisonment theory has been urged by Stich. He holds that enteric fever may arise from empoisonment by the contents of the intestine, which become noxious "under the influence of disturbing causes." This theory need not be discussed, for, as Laveran remarks, it has no precise facts to rest upon.

4. **The Theory of Dr. Moore.**—The following is the theory advocated by Dr. Moore, Surgeon-General with the Government of Bombay. This author does not believe in the specific nature of any fever, but that all belong to one genus. Enteric fever is simply a "phase of fever," and not a specific disease, whilst the enteric spots are only a petechial eruption. The eruptions of enteric typhus, scurvy, and purpura are identical. It is, surely enough, with regard to this theory, to point out that the last three eruptions do not disappear on pressure.

5. **The Vicarious Theory of Martin.**—Surgeon Martin, of the Medical Staff, has advanced a theory to account for the prevalence of enteric fever in the tropics, which demands a short notice for its reputation. He says that the following factors arise in the tropics in order, and that in consequence enteric fever is induced.

(1.) *Hepatic insufficiency.*—In consequence of an excess of work being thrown on the hepatic system, either by an absorption of putrid matter, or otherwise, there is an increased demand on the hepatic function, responded to at first by an increased activity of that function. Soon, however, the liver is unable to come up to time, so to speak, and can no longer bear the strain of eliminative work thrown on it. The second element now comes in—viz., (2.) *A vicarious and abnormal activity of the intestinal glands,* supplemental to the hepatic insufficiency. This eliminatory function of the intestinal glands at length leads to a suppurative enteritis. This vicarious action is, in its turn, furthered by the third element—viz. (3) *An idiosyncrasal proneness of the glands to this abnormal function.*

In this way Dr. Martin would explain the origin of enteric fever from "increased temperature," or its occasional "spontaneous origin," and also its non-occurrence or rarity amongst the natives of tropical climates.

Now, if it be true that enteric fever can result from "increased temperature" or "spontaneously," we are quite willing to admit

that the extraordinary reversal of the physiological function of the intestinal glands above indicated can also take place.

But inasmuch as I do not believe in such an origin from "increased temperature," or "spontaneously," I am bound to point out that the theory rests also on erroneous premisses, for, first, the intestinal glands that are affected in enteric fever are the solitary glands and Peyer's patches; and, secondly, that every work on physiology with which I am acquainted, distinctly states that the function of these glands is *absorptive* and not *eliminative*. "A Peyer's patch is merely a lymphatic gland spread out in the coats of the intestines." Still, certainly, if a tropical temperature can cause enteric fever, it can also doubtless reverse the physiological function of the different systems of the body.

Again, we believe that there is no occasion to account for the rarity or non-occurrence of enteric fever amongst the natives of tropical climates, for such, as we shall shortly show, does not exist.

Finally, Dr. Martin would seem to be in error in that he states that the fluctuating temperature of the fourth week indicates the process of suppurative enteritis. According to Liebermeister, the first week is occupied by swelling and infiltration of the patches; during the second week they either slough or subside; during the third week, any sloughs that may have formed are detached, so that, by the end of it, all the ulcers have clean floors; finally, during the fourth week, they begin to heal. There is, indeed, no process that can be properly described as a suppurative enteritis at all, but, granting that there is, we should first of all have to date the enteric fever from the date when this process begins, thus leaving out altogether the stage of glandular enlargement; and, secondly, the ulceration, which is of course accompanied by some suppuration, begins on the twelfth day or thereabouts. So far, therefore, we have as yet failed to find any basis for the prevention of enteric amongst our soldiers campaigning in tropical climates. Nor does the *transformation theory of M. Colin* help us.

6. **Colin's Transformation Theory.**—M. Colin begins by apparently falling into the same mistake concerning the functions of the various intestinal glands. He says: "All acute febrile conditions are accompanied by marked alterations in the secretions, and by gastro-intestinal complications which may induce the spontaneous development of typhoid." Now we must again insist that the solitary glands of the intestine do not secrete, but, on the contrary, absorb. Next, M. Colin says that this enteric fever is a unique malady in the tropics, and results from the transformation of fever primarily paludal into enteric fever! He also holds that, in the tropics, enteric fever may be spontaneously developed by transformation out of all acute febrile states. This transformation also especially takes place in young individuals who have recently left their native land for a warm malarial country. Now Billroth would derive all infective micrococci from a single mother-plant—the cocco-bacterium septicum. Again, a

few investigators hold that a putrefactive organism can become a specific infected organism causing a specific disease. Under either of these views, theoretically, the theory of Colin might be explained somewhat—that is to say, the cocco-bacterium septicum might first give rise to a bacillus malariæ, and then to the bacillus of typhoid. But the advances of bacteriology have shown that the origin of the different specific bacteria from one common parent is incorrect; the different bacteria, formerly indistinguishable by shape, are now easily distinguished by culture, &c. With all due respect, then, to M. Colin, I must reject his views of tropical enteric fever; nay, more, I must confess that such a pathology as teaches the transformation of one disease during its course into another is to me unintelligible. Moreover, as Dr. Welch shows: "No less pronounced is the disconnection of this disease (enteric) with the paludal fevers widely dispersed and frequently met with in the islands. Were enteric fever allied in origin to the paludal fevers, Demerara and British Guiana should have furnished a high ratio, *whereas the opposite is the fact.*"

We have, at length, finished our work of destruction, and we now come to the two remaining views of the etiology of enteric fever in the warm climates—viz., 7, the pythogenic; and 8, the specific. In fact, enteric fever arises in hot climates in exactly the same way as it does in cold. In addition, it is at once evident that, under either of the above views, we have means of prevention clearly indicated to us. I, myself, certainly incline to the belief of the specific nature of the poison; but this is a minor point, as the same means of prevention are necessary for both views. Whether there be a specific fæcal empoisonment, or a simple fæcal empoisonment, the method of dealing with it is the same—viz., to exclude all sources of fæcal contamination from ourselves, our food, our camps, and our clothes.

7. **Pythogenic Theory.**—On the pythogenic theory there cannot, we opine, be the smallest difficulty in accounting for the prevalence of enteric fever in hot climates. A perfectly astounding argument has been adduced by the climatic theorists against the pythogenic causation—viz., that on account of our good sanitary barracks our men are protected from this causation. Do the climatic theorists mean to affirm that our men never leave their barracks? and, if not, what is the argument worth? Not much, truly. Why, from the very moment the soldier lands in India he is exposed to pythogenic agencies. He drinks unfiltered water in the railway; his milk is brought, in as many cases as not, in native vessels, and not milked before him. As Surgeon-Major Ranking well states: "There is no station in India, however carefully its sanitary condition may be attended to, where the conditions for fæcal contamination of water easily accessible for drinking, though not intended for that purpose, do not exist." Not unfrequently natives wash their clothes sitting on the cover of the wells set apart for the men. How filthy are the native cooks! Does the company dhobi never mix up native dirty linen with the soldier's washing? Do the men never go to the bazaars

which, as Maclean says, "stand on soil for ages sodden with excrement?" Can any country, in cold climates, be instanced which can indeed show such forcing-beds for enteric fever, on the pythogenic theory, as the filthy cities, and towns, and villages of tropical and sub-tropical countries? And in connection with this, Dr. Welch has shown how more liable the single men are to fall victims than the married, who seldom spend their time in the bazaars. Dr. Chapple also has shown how, during twenty years of service in India, he has never seen a case contracted in hospital. But if the disease were due to climate, why should the hospital be exempt? He adds his evidence that it is pythogenic, and the source of the poisoning the bazaars. In the Twenty-first Annual Report of the Sanitary Commissioner with the Government of India, for 1884, an instructive commentary on this question appears. Cases of enteric fever occurred, and the medical officer observed that the earthenware vessels in the latrines had not been glazed, and were in fact saturated with excremental matter, and gave out an abominable odour. Glazed vessels were substituted, the offensive odour vanished, and enteric fever at once ceased. But it may be urged that cases occur so soon after disembarking that the men could have had neither time nor opportunity for contracting it. But how about the rest camps? How about the native villages near the rest camps and all their filth? And, moreover, there is not the slightest doubt that in many cases the disease is contracted before landing in India. Dr. Saunders has shown that, from observations at the Cape and in Egypt, the incubation period may be even two months in exceptional cases. Dr. Welch quotes cases proving the bearing of importation in explaining the origin of the disease amongst new-comers in hot climates. Hence, we maintain that there is no reason for seeking "climatic" causes to explain the origin of enteric fever in warm climates. Our men arrive at the predisposing age; in many cases the disease has been proved to have been imported; others, again, contract it from the filthy villages, or from unclean camps in moving up to their station; and when in the station the pythogenic causation is close at hand in luxuriant proportion. And the same factors hold equally good in war in warm climates.

Afghan war. During the Afghan war, doubtless, the cases were contracted from water poisoning by fæces, or by other forms of fæcal poisoning, although, as I shall presently show, I believe the fæcal poisoning was specific.

New Zealand, 1864. Waikato.

Again, during the New Zealand war, the staff of Government surveyors maintained robust health as long as they kept moving; but being compelled for precaution's sake, during one period of it, to remain camped near the troops, they were allocated near the notoriously bad camp of the land transport. *Enteric fever and bowel complaints soon appeared*, and affected more or less the majority of the survey staff. The affections were only arrested by a change of position.

Zulu war.

During the Zulu war, on the occupation of the *new fort*, Chelmsford, near Gingoloro, built on new ground be it noticed, a native

contingent was encamped in its neighbourhood. The conservancy arrangements of this contingent were primitive. Soon cases of enteric fever broke out in the fort, and the sick became so numerous that they had to be moved down. Now, besides the dirty native contingent, and the absence of sanitation in this camp, dead bodies of Zulus were found in the surrounding marshes from which the drinking water had to be drawn.

An objection has been drawn by certain observers to the specific or pythogenic causation as regards Afghanistan, that enteric fever occurred in "virgin" camping-grounds. But as far as my experience went—and I had the good fortune to see the whole of the Kurram and Khyber lines, and half of the Quetta Candahar line—the camps were near villages for the sake of getting supplies; if the camps were "virgins," the villages certainly were not so, but afforded ample pythogenic sources of infection. Finally, in the Nile expedition, although as a rule the medical officers reported favourably of the sanitation of the camps, yet there were exceptions. Wady Halfa was reported constantly to be in an unsanitary condition from November 1884 to November 1885. "The ground was foul from the Egyptians defecating all over the place." At Assouan the foreshore of the river in front of the port was in "a very insanitary condition."

8. **The Specific Theory.**—I cannot, however, personally help believing that something more than mere fæcal poisoning is required. Any one who has perused Dr. Budd's delightful classic on typhoid fever as it occurs in England, must believe that it is due to specific poisoning in England. He shows how accumulations of filth might exist for years in country villages without any enteric fever arising; the inhabitants thereof might breathe the polluted air, and drink the polluted water, yet no enteric fever resulted, until the missing element—the enteric stools of a chance visitor sick from enteric fever—were mingled with the fæcal accumulation.

Dr. Budd's views.

Similarly, Welch has shown facts for enteric fever in hot climates, demonstrating that "the specific theory more closely embraces the military data than any other, and is the only one that meets the requirements of the case." It may be true that we cannot always find out the first case causing infection, but the same is true of every other infectious disease. Abundant sources of infection exist in the East: in the bazaars by contaminated drink; by watered milk; by effluvia; through the dhobis, by their washing clothes with infected clothes, or in infected water; by inhalation of the air containing dried particles of infected excreta. Dr. Deakin, of the Bengal Medical Service, as the result of an experience of ten years in India, stated that he has "never yet met with a case of cholera or enteric fever in which the possibility of a specific source of contagion could be eliminated; and that as long as this is the case he fails to see the necessity or desirability of starting any 'climatic' hypothesis of causation." In fact, sources of infection flourish luxuriantly throughout warm countries: in the bazaars, villages, streams and fields.

Dr. Welch's views.

Surgeon-Major Deakin's views.

All we want is a first case; and he must be a bold man who will deny the existence of such a case in any outbreak. And be it remembered that the very mildest case is all that is necessary for the *fons et origo* of an outbreak; the stools are as equally and as powerfully infective as those of the severest case; how often may such a mild case be overlooked? Dr. Murchison describes the *abortive* form in which the fever may terminate at the end of a week; Griesinger is quoted for cases ending in five days. Such cases have been returned as "febricula," and excusably so; for it is difficult to see how they could be diagnosed when occurring solitarily. But that such cases of enteric do occur is shown by Murchison, who has found the characteristic eruption in them; and who has also found them occurring in the same house with typical cases of the disease. Other cases, not recognized as such, occur under "The Insidious Form," described by Hewett, Louis, and Chomel, and by the Germans as "Typhus Ambulatorus." Therefore, it should be a rule on service to regard all cases of fever with diarrhœa as possible cases of enteric, until proved otherwise. To clench this etiology, the truth of which we firmly believe, two other facts must be established:—First, that native races are subject to enteric; secondly, that there is a germ specific to enteric. These facts I propose finally briefly to establish.

Natives are subject to nteric.

Notwithstanding the fact that Dr. Marston considers the occurrences of enteric fever amongst natives to be very rare, yet there is abundant evidence that the contrary is the fact.

Sir Guyer Hunter, for instance, as regards natives of India, from his experience as Professor of Medicine in the Grant Medical College, Bombay, and other places, states that no race or sect is exempt. Hunter has seen it in Hindoos, Mussulmen, Parsees, &c. Dr. Scriven, of Lahore, also bears the same testimony for the Punjab. Dr. De Renzy, in his report for the Punjab in 1869, draws attention to the enteric fever prevailing in the gaol at Rawal Pindi, and gives perfect histories and post-mortem examinations. In 1872, thirteen cases of enteric fever are returned from the Bengal native army. It has also been reported, and on the strength of post-mortem results, by Chevers for Bengal, Crombie for Burmah, O'Brien for Assam. Dr. O'Brien's report is particularly interesting, as showing the existence of enteric fever among the native hill population, and the introduction of the disease into a corps and station by recruits joining: the outbreak occurring at Shillong in the 44th N.I., four of the cases being recruits, and admitted a few days after joining, from whom other cases occurred. Enteric fever also is returned as occurring among the Bombay coolies at Mauritius; it has also been returned for Madras; in fact, that the disease is common to the community at large in India, irrespective of race, is indisputable. In other tropical countries, again, *e.g.*, the West Indies, it is found. Welch finds, from an examination of the returns of Jamaica that, excluding Newcastle, the black troops have more frequently been affected than the white. Again, the black troops on the West Coast of

Africa give returns. Dr. Allen has found it amongst the Africanders, Kafirs, Zulus, and coolie class. It is prevalent amongst the native population of Algiers. In 1884, the principal medical officer in Ceylon has found it frequent amongst the natives. Finally, Hirsch shows that there is no racial exemption. He quotes Tidyman in proving its frequent occurrence amongst the negroes of the Southern States of the Union; also Lewis, who states that "hundreds of negroes died of typhoid in Central Alabama in the winter of 1835–7." Hence, we think we have adduced evidence sufficient to supply the link connecting enteric fever with British troops as regards its continuous origin from the native community in warm climates.

Next, as regards the *specific* origin and nature of enteric. Although it is true that if we hold fast to the poisoning by any and all excreta as the main point as regards our preventive measures to be guarded against, we shall have equally good results as if the excreta contained a specific poison—I think it necessary to support my opinion by a brief *résumé* of the researches tending to establish it. Virchow, a few years ago, in his address on "Enteric and Infection Diseases in the Army," drew attention to the fact that enteric was suspected of being propagated by "plantkins," and he also showed that as the minutest organism makes its first start in the way of regular heirship from a predecessor, if this be the source of any contagion, it follows that such contagion cannot spring *de novo*. Now many pathologists claim to have found a specific bacillus for enteric fever. Klebs (*Archiv. für exp. Path.*, vol. xii. parts 2 and 3, and vol. xiii. Hefte 5 and 6) has found bacilli constantly present. The tissues beneath the typhoid ulcers is said to be full of them. They occur constantly in the intestinal infiltrations, and also in those anatomical lesions which are said to be secondary. In one case of ten days standing in which the cerebral symptoms were especially marked, these bacilli were found in the pia mater. They are in length about 80 micro-mm., in breath 5–6 micro-mm. Eberth independently came to the same conclusions. Koch has confirmed these observations. Further, Maragliano has found these bacilli in the blood of enteric fever patients during life. And he found also that as convalescence approached they gradually disappeared. The experiments on animals of these observers confirm the notion that the bacillus is specific. By subcutaneous infection in rabbits, Klebs found his bacillus to develop in their intestinal mucous membrane into the same form of mycelium as he found pervading the whole mass of a typhoid patch. The histological changes in the two cases corresponded; and thus his conclusion that this bacillus is the essential cause of enteric fever is confirmed. Dr. Almquist, of Stockholm, from culture experiments from the bacilli from the blood of enteric fever patients, inoculated a dog. On the 15th day he found Peyer's patches much swollen, and containing the same bacteria. In a paper, entitled "The Typhoid Plant and its Favourite Soil," in 1884, read at the London Sanitary Convention, Dr. E. Playter, of Ottawa, fully adopted the doctrine

Specific bacillus.

Virchow.

Klebs.

Eberth.

Koch.

Maragliano.

Almquist.

Playter.

that the specific cause of enteric fever was the bacillus; he pointed out also that its favourite soil for growth outside the body was human fæcal matter, and hence theory indicated prevention—viz., the most scrupulous disinfecting of the same.

Gaffky.

Dr. Gaffky, in the second volume of the Reports of the German Imperial Board of Health, gives a very complete contribution on the "Etiology of Enteric Fever." His research is based on a microscopical examination of twenty-eight cases. In only two out of twenty-eight cases were no bacilli found. Gaffky has made many pure cultures, and is satisfied that this bacillus is distinct from other pathogenic forms. He failed, however, in inoculating animals. He holds them, nevertheless, to be the specific pathogenic organism.

Bouchard.

M. Bouchard, in his paper on the "Antiseptic Treatment of the Acute Infectious Diseases," read at the International Congress at Copenhagen, describes a bacillus which, after five years' study, he has found in all the pathological new formations occurring in connection with typhoid fever, except the sudamina. He considers it to be the causal agent. Animal experiments have failed. It was easily cultivated on bouillon, and its proliferation was prevented by biniodide of mercury.

Shpolansky. Stroganof.

Lastly, Drs. Shpolansky and Stroganoff, of Odessa, examined bacterioscopically the stools in ninety-six cases of enteric fever, and found Eberth's microbes present in ninety of the number.

Conclusions.

From a review of the evidence, it seems that the bacillus of Klebs has considerable support, both from the many confirming observers, and also from the fact that experiments on animals were confirmatory. I have entered rather fully into the history of the specific bacillus of enteric, for, whether true or false, the germ theory is the best working hypothesis from a sanitary point of view.

I hold that there is no subject of greater importance for the military surgeon than the prevention of enteric fever in campaigns. I fully agree with Dr. Flint as regards his dictum that it is possible in course of time to get rid of typhoid fever altogether, and that the spread of the disease from any given patient is absolutely within our control; but the primary process must commence with ourselves. Our troops before starting on a campaign must be located so that they cannot possibly get infected. To effect this, there must be sanitation in reality. As the *Indian Medical Journal* observes, "When we read the report on the sanitation of Calcutta (*Lancet*, February, 1871, p. 656), and contrast it with the disgracefully filthy condition of the native bazaars, the fort moat, and the 800 disgustingly filthy tanks (which, thanks to Dr. A. T. Payne, have nearly all disappeared, but which to our knowledge existed in 1874 in the City of the Palaces), or when we consider the unhealthy condition of the town during the past two years, we learn what remarkably different ideas some people have as to what constitute local insanitary conditions." And yet Sir Joseph Fayrer and others state that European theories will not account for enteric fever in India!

We, indeed, can but marvel at the confidence with which statements are made as to the non-existence of any specific source of contagion in any given case occurring in an Indian cantonment, station, gaol, or native city.

The preceding exposition will show then the lines on which we should start our men with a healthy body on a campaign from India or any other warm country. It now remains for us to indicate how, further, we are to keep them free from enteric during the campaign. As Liebermeister states, typhoid fever is one of the diseases best calculated to test the efficacy of whatever precautionary measures and enactments that may emanate from the domain of State medicine. "Prophylactic measures will be effective just in proportion to the strength of our belief in the material nature of the typhoid poison, whilst therapeutic half-measures will yield, not half-way results, but no results at all." As regards India also, Prof. Du Chaumont states "there is too much continued fever, that is, typhoid, and this is distinctly preventible." And what is true of India, we believe is also true of tropical campaigns. Now, how is it distinctly preventible? We will again quote Liebermeister for our answer: "A man who avoids breathing the exhalations of privies and sewers, who does not handle linen foul with typhoid dejections, who does not drink unboiled water from infected springs, is as safe in a place where a typhoid epidemic is raging as in one where not a case of the disease exists." Now, substitute "camp trenches" for "privies and sewers," add "exhalations of dejecta generally," and we have given us the keynote of prevention.

Before proceeding analytically to discuss the prevention of enteric in tropical campaigns, let us look into the conditions present during the operations of war in Egygt, in order finally to see whether there is any necessity to invoke climate as a cause. We cannot, indeed, learn in what ratio enteric fever occurred as Egypt, regards the force arriving from England, as the classification 1882. employed for the returns simply divided fevers into "paroxysmal" and "continued." But continued fevers returned 73.5 per 1000, as compared with 17.7 per 1000 for paroxysmal. Under the "continued" lay an unknown quantity of enteric. Dr. Colvin Smith, however, we have seen, gave a perfect return of "fevers" under "ague," "febricula," and "enteric" for the Indian Contingent. Now, out of a strength of 131 officers and 5674 men, only one case of enteric fever was returned, as compared with 123 cases of ague and 28 of febricula. Supposing this return correct, and it doubtless is, it goes far to prove the opinion that many cases of ague with typhoid symptoms, *i.e.*, ague—including intermittent and remittent fevers—with a severe course, ending in the supervention of the typhoid state, have been, and are, returned as typhoid fever. As regards, however, the general causation of enteric fever in this Egyptian campaign, Dr. Marston, the sanitary officer, has placed it on record that European theories were not sufficient to account for it, especially as regards the theory of the water-supply. Independently, however, of the fact that a second observer, Sur-

geon-Major Warren, expressed quite the contrary opinion, Prof. Maclean, in reviewing the whole evidence, rightly, as we think, declared that the cases in their etiology and course exactly resembled those occurring in Europe, and were not due to "vague climatic causes." Let us, however, briefly cast in review the environment on which Marston grounded his climatic theory. First, we had the advance along the Fresh-water Canal. Now here the men had the most indifferent drinking water. It is true Norton's tubular pumps were in use, and that wells were dug alongside the canal at a little distance from it, to try and ensure the filtering power of the soil. But is it at all likely that the men, burning with thirst under the hot summer sky, restricted themselves to such water? and if so, did the pumps act? The men most certainly did not so restrict themselves. Now, the accounts of the fouling of the Fresh-water Canal most fully would explain the enteric fever, especially on the pythogenic theory, and to our mind, the only wonder is that a vast epidemic of enteric fever did not devastate the force. In the second place, consider the conditions at Ramleh, Alexandria, Cairo, &c. The atmosphere was loaded with the dust of the soil, and we need hardly allude to the fact that this dust was about as foul as dust can be. It was emphatically excreta laden. This dust, then, everywhere encompassed our force. Blown about the camps, our men both inhaled and swallowed it. Let us, just for a moment, quote the condition of Cairo in April 1885. Mr. Ernest Hart, who describes them, found the insanitary conditions indeed worse than they were five years ago. "The permeation of the soil with putrefactive filth is continually increasing. The system of watering the stinking earth in the noonday sun makes the air reek with stenches." The soil reeking with filth, with all natural dry-earth conservancy absent; the drinking water becoming annually more and more polluted; cesspools emptied at uncertain intervals without warning; the contents of the cesspools bucketed into open barrels, and the carts then loaded with these barrels, such carts, on their way to the desert to deposit the filth there, jolting the contents at every step, and splashing the contents into the air and into the dusty road. Such were the conditions of Cairo in 1885. And, of course, such have been the conditions for many years. Surely, Mr. Ernest Hart must have had the climatic theory of enteric fever in his mind when, in commenting on this condition of Cairo, he writes: "People often wonder where their children get enteric fever, diphtheria, ophthalmia, &c. The reply is easy—in the street." And such were the streets which our soldiers thronged after the seizure of Cairo; and such was the dust of the desert blown through our camps. Again, in 1886, the sanitary state of Cairo was no better. "The water-supply was derived from a stagnant canal, emitting abominable odours from human filth. There was nothing deserving the name of a system of sewerage and drainage. Typhoid fever is very prevalent." Looking only at pythogenic causes, we find a perfect hot-bed for the disease; but we know also that enteric fever itself prevails in Egypt. Thus Cerf-

Mayer, as regards Alexandria, states that "typhoid fever with the same symptoms as it presents in Europe has its place in the list of diseases." Vauvray states that the deaths from typhoid in Port Said amount to 6 per cent. of the mortality; whilst Penay describes the disease as not only being prevalent at Khartoum, but also very widely spread and very malignant.

Selection of Men.—Turning now to the more congenial task of indicating the nature of the preventive measures for enteric fever in tropical and semi-tropical campaigns, we come first to the selection of material. We cannot, indeed, now take advantage of the selection of men of an age not especially predisposed. Owing to the short-service system, our men arrive in hot climates 1. Age. just about the age when most predisposed to enteric fever. Under the long-service system we could have selected men past the dangerous age. Welch (p. 100) quotes some Madras figures showing that if soldiers of twenty years and under were kept out of India, the enteric fever would decrease, whilst, if the exclusion were extended to twenty-five years, it would have very small proportions. Nevertheless, in 1884, 2000 recruits were sent to India who were under twenty, and most of them were but little over eighteen! For a campaign on the frontiers of India we 2. Previous service. should select the British regiments, when required, from those who have been some time in India, thus bringing to our assistance the aid of acclimatization. I would urge that all men having a previous history of enteric fever be scrutinized with the 3. Previous enteric fever. greatest care before being allowed to take part in a campaign. Such men are rarely fit to undergo the arduous fatigues of a campaign, especially in the tropics. Dr. Bristowe draws attention to the liability to the supervention of pulmonary inflammation and tuberculosis subsequent to enteric fever; this liability must be greatly enhanced by fatigue and exposure. The recent researches of MM. Landouzy and Sireday establish the injurious effects of typhoid fever on the heart and great blood-vessels. Virchow, again, shows how even the most robust, after recovery from enteric, may suddenly break down. Finally, we know from Zenker's researches that the voluntary muscles undergo degeneration in enteric fever, leaving, it may be, their structure impaired even after recovery, whilst he has drawn, also, especial attention to the cardiac muscular degenerations that occur. These latter researches have again been carefully investigated by Hayem, who has shown not only the granular degeneration of the muscular fibre, but also the small-celled infiltration between the fibres, leading to connective-tissue growth. Such changes must inevitably leave an impaired heart, and an impaired heart is unfit for a campaign. Lastly, all men with malarial infection should be 4. Malaria. weeded out. Dr. Scriven, late civil surgeon of Lahore, has drawn attention to the fact that "persons weakened by malarial fever are peculiarly liable to true enteric fever."

Selection of Season.—Although enteric fever exists throughout the year, and is independent of season, yet it is more prevalent in certain seasons than in others. Now, for Europe, Murchison

shows its increased prevalence in autumn—the months, in order of relative frequency, beginning at the highest, being October, November, September, August. But, luckily for our campaigns in warm countries, the seasonal prevalence is different. Enteric fever here prevails mostly in the hot and rainy months, and not in October and November, the months in which campaigns had best begin. Welch, for India, shows that the enteric-fever ratio rises with the heat, recedes before it culminates, advances again in the rains, and finally falls rapidly with the cold weather. Again, although the relative greater frequency in the different quarters of the year may not coincide in all the three presidencies, yet in no year is the maximum during the fourth quarter. As far as the seasons are concerned, heat and rainfall are the factors favouring enteric fever. Finally, Hirsch draws attention to the "noteworthy circumstance" that the hot months are the chief seasons for enteric in tropical and sub-tropical regions. The indication, then, is obvious—to begin the campaign with the advent of the cold season.

Clothing.—We need only repeat here the precaution of continually wearing a cholera belt or flannel waistcoat; not so much, indeed, for the strict prevention of enteric fever, but for the preservation of the abdomen from chill and subsequent catarrh. For it is obvious that enteric fever would be more likely to occur when the resistance of the "site of election" is functionally weak and functionally weak it must be in catarrh.

High ground.

The Camp.—The site of the camp should be as high as possible, and on the driest ground available. Ground with a moist subsoil should be avoided, and likewise permeable soils. I do not, indeed, state this on Pettenkofer's theory, which I do not hold proven, but I state it on the ground that the enteric-fever germ, or putrefying fæcal matter, would have greater impetus for development in damp soils.

Open order.

There must also be the most open order possible of the tents. The free ventilation of the camp is imperative, and, as we shall see, the trenches must be as remote as possible from the tents.

Change site regularly.

Again, the site of the camp should be changed at regular intervals. Morache draws attention to the greater prevalence of enteric fever amongst the French troops at Metz over the investing German army, pointing out that, whilst the latter, within certain limits, could change its camping ground, the French were compelled to encumber the same ground for three months. One can easily imagine how enteric fever, once started, would increase under such circumstances, and how, under the pythogenic theory, causation and prevalence must inevitably arise. And if this occur in temperate, how much more in tropic climes. Fleet-Surgeon Norbury, again, well points out how he has never seen enteric fever occur in an active flying column, but that, when it did appear, the camp was always one of some permanency.

Relation to malaria, Boudin.

Boudin has stated that there is an antagonism between malaria and enteric fever, and has, with others, shown how malarious sites, when drained and rendered non-malarious, have become the seat of enteric fever. Hence, one might foolishly

urge that a malarious site is advantageous against enteric fever. But the real explanation of Boudin's observation is, that draining malarious sites makes them habitable, and with habitations come inhabitants, and with inhabitants enteric fever. Dr. Allen, in his work on enteric fever in relation to cattle, urges that, for temporary camps, it is safer to choose places where the grass is thick and high, rather than the bare earth, because on the latter lies the contagion from which the calves have become affected. The grass offers a natural barrier between the bodies of the sleepers and the contaminated soil. Where, however, the bare earth must be chosen, the waterproof sheet is the only precaution. When the camp becomes permanent, then the site on which each tent stands should be copiously watered by a disinfectant solution. Dr. Allen's views.

Finally, especial preventive care is indicated should circumstances compel camping on sandy soil. We have before alluded to the part the sandy soil of Egypt played in enteric fever. Amidst the dirt in the air, dried particles of excreta become diffused. Should disinfection of the excreta again be inefficiently performed, dry sandy soil of itself can lend little aid to disinfection. The same precautions as were suggested for ophthalmia are indicated, the camps must be regularly watered by bheesties to lay the dust, especially in the neighbourhood of the latrines. Water. Sandy soils.

Food.—That precautions as regards the meat supplied to the men are necessary, will be evident from the following facts which have been brought forward to show that decomposing meat, *per se*, can cause enteric fever when eaten, and that the decomposing meat of animals suffering from enteric fever can do so. Thus, in the first class of cases, Dr. Bruce Low gives two cases where the disease seems to have been caused by (1) inhaling the effluvia from a decomposed hide; and (2) by eating decomposed American bacon. Dr. Low, however, states, the animals may have had enteric fever. Griesinger relates an instance of a festival in Switzerland, at which, of 600 persons who had eaten of some decomposing veal, more than 500 were subsequently seized with enteric fever, whilst no one who had abstained from this veal was attacked. But it is highly probable that the flesh then eaten came from animals who had suffered from enteric fever. There is an accumulated mass of evidence to show that animals do thus suffer—and if so, there is reason for belief that eating their flesh will cause enteric fever in man. Creighton has shown the probable connection between tubercular disease in man, and "perl sucht" in the cow by means of the milk; and why should there not be a similar connection as regards enteric? It is true that Murchison obtained but negative results on feeding a pig with fresh stools of a patient with enteric. But Sutton has shown the disease to occur in monkeys. M. Tayon, in his communication to the French Academy in 1884, showed that inoculating guinea-pigs with the culture results of the blood of an enteric-fever patient, produced typhoid lesions in these animals, whilst the same lesions were produced in a less virulent degree in sheep, dogs, and cats. Welch states that cattle suffer from it. Animal food. Bruce Low. Griesinger. Creighton. Sutton. Tayon. Welch.

Huguenin. Huguenin, also, in commenting on the numerous outbreaks that have been reported as arising from diseased meat in Switzerland, states that enteric fever, with characteristic intestinal lesions, is common amongst cattle in Switzerland, and gives evidence showing that calves became infected from the stools of their owners. He states, however, that the meat must be also decomposed.

An interesting outbreak bearing on this point has been reported Marston. by Marston. During July and August 1879, enteric fever prevailed amongst the men of the 70th Regiment at Subathoo. At the same time, a fatal disease with high temperature, diarrhœa and emaciation, and disease of the intestinal and mesenteric glands made its appearance amongst the sheep maintained by the commissariat for the supply of mutton for the troops. The issue of this mutton was prohibited, and stopped on August 3. The last case of enteric fever occurred on August 20, or eighteen days after the cessation of the issue of the mutton. The drinking water was pure. The above sequence of events certainly showed apparently a sequence of event to cause. But it was found, also, that the fever was originally contracted at Mooltan, and not at Subathoo. The first case occurred at Mooltan on March 26, then six cases occurred during the transit to Subathoo, the first case occurring at Subathoo on April 21. Head-quarters arrived at Sukathoo May 23. The last case in the regiment occurred as above, on August 20.

Dr. Allen's views. With regard to the origin of enteric fever from infected cattle, Dr. James Allen, of Pietermaritzburg, has drawn especial stress to this mode of infection. Enteric fever is the only disease endemic in South Africa, being a disease of the spring and summer, and affecting all classes and races impartially. Dr. Allen concludes that the disease was present in the country before the first arrival of the colonists, and that its propagation is not dependent upon human beings, but upon infected cattle. He describes a specific enteritis occurring in calves, subject to relapses, and very contagious, and holds that the ordure of animals affected with this specific ailment, on gaining access in any way into the human body, will give rise to enteric fever. An outbreak is narrated supporting this view, and the disease was started in a calf by causing it to drink water impregnated with the ordure in question. Men are infected by the dried excreta, blown about in all directions, or by the saliva of the calf left on the mother's dug infecting the milk, or by infection of the drinking water. Dr. Allen holds that enteric fever thus arose in a great measure, amongst our troops in the Zulu war.

From a survey of all the above facts, it seems certain that the lower animals, such as sheep and cows, &c., are subject to enteric fever; and it also appears that decomposing flesh, specifically affected in some cases, has been considered to have caused outbreaks of the fever. Whether we hold the specific view or not, we at any rate must urge careful scrutiny of the meat supplied to the men, and especial precaution be taken that not the slightest decomposition be present in the meat. It is quite possible that

some of the so-called inexplicable cases of enteric that have been related may have arisen from eating infected preserved meat. Although we, ourselves, firmly hold the specific theory of enteric fever, and consider that, if mutton and beef do cause enteric fever to man when decomposing, that such meat must also be specifically infected, yet the right course to pursue is to follow the advice of Roth and Lex, and act on the possibility of pythogenesis and fermentation of perhaps other forms of organic matter, as the causes of enteric fever; always excepting, however, the "climatic theory," which is barren as regards any indications for treatment.

An undoubted *rôle* is played by the drinking-water. Pettenkofer, indeed, denies any influence to the drinking-water, but, as Roth remarks, how can a poison developed on Pettenkofer's theory, in the ground, during the sinking of the ground-water, avoid getting floated into the ground- or spring-water? According to the recent experiments of E. Bagenoff on the action of various agents on the bacilli of Eberth and Koch above mentioned, water forms an excellent medium for their preservation and growth. Milk also was found, but to a less extent, an excellent medium. Water.

The enteric fever during the Zulu campaign was considered by Dr. Woolfreyes to be solely induced by polluted drinking water. The outbreak at Ramleh, as shown by Dr. Warren, had a like causation. In the recent Khartoum expedition enteric fever was shown to seize those who drank of the polluted water of the Nile in the Cairo camps, whilst those in the same camps who were supplied with distilled water remained exempt. At Assouan, it was reported in December 1884, that "the water supply was not good, as we are about 300 yards below the fort occupied by 200 Bashi-Bazouks, and numerous women and children. The foreshore is in a very unsanitary condition." Again, an extensive epidemic occurred at Bangalore in 1884, in the mounted branch. Dr. Martin found that it was due to the fact that the men, whilst at "stables," were supplied with unboiled water, direct from the bheesties mussacks, without any process of purification. The unpurified unfiltered water on board foreign ships was found invariably to account as a factor in the prevalence of enteric fever in the merchant service, when I was resident at the Seamen's Hospital, Greenwich. Zulu. Egypt. Bangalore. Seamen's Hospital.

Although unconnected with campaiging, yet I cannot forbear, on account of the lesson it teaches us, from briefly alluding to the late terrible epidemic of enteric fever at Plymouth, Pennsylvania. This epidemic is especially instructive to those authors who hug climatic theories, inasmuch as within a few days 1000 persons were infected by the drinking water polluted by the stools of only one patient. Luckily for science, the hard-headed American, sceptical, after the manner of his race, of vague and subtle theories, investigated the outbreak. But suppose, for a moment, the single case had eluded his observation, and suppose also that the whole outbreak had occurred in a tropical climate, can any-

one doubt in what light its causation would have been held by those who have, of recent years, promulgated the climatic doctrine.

The Plymouth epidemic, 1885.

The town of Plymouth is situated on the Susquehanna River, in Pennsylvania. The main street of the town is parallel to the river, but a large number of the inhabitants live on ground extending towards the sloping mountains behind it. The general health up to the date of the outbreak had been average and fair as usual; its sanitary state was not worse at this time than on preceding years. In the second week in April 1885 an epidemic of enteric fever broke out, and within one month over one thousand were seized, with 90 deaths. The water supply was at once suspected, as all parts of the town were affected, the clean as well as the healthy, and a committee was appointed to examine into the question. They elicited the following facts:—The water supply of Plymouth is from two sources—(1) from private wells, and (2) from hydrants directly under the control of the Plymouth Water Company. Now, the well water was not at fault, as the disease was found wherever hydrant water was used, *and only there.* The people who drank only of well water escaped. The hydrant water was derived from two sources: (*a*) during the greater part of the year from a mountain stream of great purity, which, after leaping down the mountain side for several miles, is distributed through the various streets by pipes running from the lower or first of four successive reservoirs, which have been formed in the stream; and (*b*) when the water in this stream is quite low from water pumped directly from the Susquehanna river into the mains. Such was the case from 20th March to 26th November. A man convalescent from enteric fever was found by the committee living in the only house on the banks of the mountain stream between the third and fourth reservoirs. This house was within 40 feet of the stream. The patient had contracted enteric fever when on a visit to Philadelphia in the latter week of December 1884; the disease manifested itself at Philadelphia in January; on his return home he suffered from a relapse, and was ill for several weeks through February and March. During his illness, the snow being on the ground, his excreta was thrown on the ground within a few feet of the stream supplying the town. Thus they accumulated on the ground close to the stream. From March 25 to March 31 the snow was melting; early in April there were frequent showers with mild warm weather. These thaws and rains removed the snow, and with it the dejecta, directly into the water supply. The first case of enteric fever was reported on April 9; this occurred in the practice of a physician who saw thirteen more cases within the next five days, when a large increase took place, seventy-five cases being seen by one physician between April 14 and April 19. Thus the great outburst flared up about the middle of April, beginning gradually however on the 9th.

As we have seen, the mountain stream was not in use from March 20 to March 26, but Susquehanna river-water. Had

this water anything to with it? No; because (1) cases occurred in houses which had at no time used river-water, such as were situated at the reservoirs, and were enabled to obtain enough from them for their purposes. (2) Cases occurred amongst visitors to Plymouth who arrived a day or two after the mountain-stream was again supplying the town, and who, therefore, had never used river-water. (3) The incubation period does not correspond to the supposition that the river-water was the cause, for allowing 10–14 days for this period, cases ought to have commenced about March 30 to April 2, whereas the first case did not occur till April 9. Now the reservoir mountain stream water began to be used again March 27, and the first case occurred on April 9, or thirteen days after; but the water becoming more freely distributed, the great outburst occurred from April 14. The evidence, we think, is conclusive.

Now this remarkable case shows how, within a month, an epidemic can start from one case and affect more than 1000 people; it also again shows how true is the fact insisted on by so many authors, of the tenacity of vitality of the enteric poison, such tenacity lasting through a frozen temperature; and, finally, it shows us how necessary it is to disinfect the excreta of such patients.

All water to be boiled.

Many more examples in the history of campaigns again could be cited of the part played by the drinking water in the causation of enteric fever. Enough, however, has been stated to show the imperative necessity of strict attention to the water supply, and strict disinfecting of all water wherever obtained. Prof. Du Chaumont indeed recommends all water to be distilled on campaigns; this might be carried out at the base, but along the advanced lines would, we fear, be impracticable. The site fixed for obtaining the drinking-water from a river should be guarded from all pollution; it should be higher than the sites for washing, and above all fords used for cattle. The same caution is indicated as regards milk. Milk obtained from native villages on campaigns is, we believe, a frequent source of infection. In the Nile expedition, 1884–85, the medium of milk was held to be a possible source of infection. The goats supplying the milk were not milked at the camp or hospital, but the milk was brought by natives from their houses in gourds, and was hence greatly liable to contamination. It is true that it has been held in India that milk does not cause enteric fever, "because children who consume most milk suffer least." But the fallacy of such logic is transparent, for, of course, it is not the milk, but the milk plus infected water added to the milk, or milk infected in the bazaars. But how many obtain this milk from the bazaars? Milk in the vast majority of cases for Indian children is obtained from the cow or goat private in the particular compound. Hence, boil all milk before distribution, and make the villagers supplying it milk their cows in camp before those reponsible for its distribution. And again, let the calves of the cows brought for milk be examined to see that they are in good health, and not suffering from any enteritis. One more caution must be added finally for the preservation of

Distilled.

Milk.

Dr. Cuningham on milk in relation to enteric fever.

food from infection. As far as possible it must be protected from flies. Fleet-Surgeon Norbury has drawn attention in this respect with regard to enteric prevailing in the campaigns of South Africa. He holds that flies are great factors in its production; swarming in latrines, they fly about with their fine hairs coated with infectious matter, which they deposit on solid articles of diet or on potable liquids.

Conservancy.—"The disposition of any locality to typhoid fever depends largely on the extent to which the inhabitants breathe and drink the contents of their privies." This dictum of Liebermeister may be applied to the camp with due substitution of trenches for privies. We have already repeatedly drawn attention to the ventilation and open order of the camp. Next, the trenches—distinct for enteric-fever patients—must be as far to leeward of the camp as possible. The trenches must especially be so situated as to prevent any effluvia permeating the camp; exhalation from drains causes enteric in civil life, and exhalations from trenches will do so in camp. In a permanent camp on the line of communications, owing to its necessary compression, enteric fever once started, is much favoured, for the ground set apart for latrines becomes more and more occupied. The outbreak of typhoid fever which proved so fatal to the French troops at Tunis is shown by Dr. Siredey to have been imported by the soldiers themselves; the epidemic spread from regiment to regiment, and became intensified owing to the neglect of the most elementary

Treatment of excreta.

rules of cleanliness and hygiene. Hence, the treatment of the dejecta is of primary importance. The first point is to dispose of them as quickly as possible, as the generality of evidence points to the fact that the stools when first voided are not infectious. Next, we know that the vitality of the "ferment" is very great. We must accordingly render the stools unfit to support the enteric germ. Many facts show (*e.g.*, the epidemic in Lausen of 1872 quoted by Roth) that the fluid excreta of enteric stools can soak through a considerable thickness of earth, without losing their infectious properties, especially when the structure of the soil is loose. And this is particularly the case where sandy soils are concerned, as in Egypt. Such soils can scarcely be said to possess any disinfecting power at all. We should therefore in no case

Sawdust and burning.

depend on the power of the soil for disinfection. Some have recommended mixing sawdust with the stools and burning them, but it is difficult to see where the sawdust is to come from on a

Petroleum.

campaign. Dr. Du Chaumont recommends carrying petroleum for the purpose; this method has advantage also of supplying a

Simple burning.

material for the cremation of the dead. Simple burning cannot be depended on to destroy the infective power of the stools. "Typhoid stools were burned in a dunghill. Some five weeks later, five persons who were employed in removing dung from this heap were attacked by typhoid fever; their alvine discharges were buried deeply in the heap, and nine months later one of the two men who were employed in the complete removal of the dung-heap was attacked and died" (Cayley.) This instance

imparts most important lessons; it shows the inefficiency of simple burning to destroy the infecting power of the stools; and it shows also how prolonged is the vitality of this infecting power. It is better therefore not to depend on simple burning, for it may be carelessly done. In the New Zealand war, however, the excreta were burnt, it having been found that burial was of no use; for independently of the scavengers not burying the excreta at sufficient depth, it was found that the ground after a time became saturated with organic matter, and emanations were given out; whilst after heavy rains the putrefying heaps became exposed.

The best plan is to chemically disinfect the stools as soon as they are passed, and then to bury or burn them. The infectious properties of the stools appear to be developed in about twelve hours (Cayley). Hence, disinfect at once. The methods are, either to strew the receptacle into which the motions are passed with a layer of sulphate of iron, each time before being used, and then, immediately after use, to pour some crude hydrochloric acid over the fæcal mass—as much as one-third, or one-half of the bulk of the motion being used (Liebermiester); or, to employ carbolic acid (1–40) for the same purpose (Murchison); or, to use chloride of lime, as especially recommended by the committee on disinfectants, of the American Public Health Association. Four ounces of chloride of lime of the best quality (*i.e.*, containing at least 25 per cent. of available chlorine) are to be dissolved in a gallon of soft water, and one pint of the solution to be used for each motion. The advantage of chloride of lime is the shorter time of exposure to this agent that is necessary.

Chemical disinfectants.

Liebermeister. Murchison.

But for portability, and as regards its applicability for general use, I would recommend corrosive sublimate. Wilson strongly urges its advantages for disinfecting the stools of enteric fever. In using this agent, all hard, fæcal lumps should be well broken up, and the dejecta then exposed to the action of the agent for one hour, then trenched, some more sublimate, finally, being poured over the mass and the surrounding earth. The strength of the solution required is 1 in 500. All vomit should be treated in the same way; whilst the committee above mentioned also have recommended treating the urine with the disinfecting solution. In relation to the great preventive effects of corrosive sublimate on the infection of typhoid fever, I may, in conclusion, draw attention to the experiment of M. Chautemesse. He found corrosive sublimate, of the strength of 1 in 20,000, destroyed the vitality of the typhoid microbe, whilst carbolic acid, in the strength of 1 in 400, had no effect on it.

Corrosive sublimate.

Treatment of vomit and urine.

Chautemesse.

The trenches must, of course, be so situated that there is not the slightest chance of contamination of the water supply. They should be not less than 1½ feet deep, and 1 foot wide. When the trench is half filled it is to be closed, and the earth well beaten and stamped down. It is very important not to simply shovel in loose earth, but to beat it well down; for, it may happen that the ferment has not been entirely killed, and, should any decomposition set in, with liberation of gases, the poison will be carried

The trenches.

with their upward movement through the loosely shovelled in earth, and may poison the atmosphere. One more caution is necessary. Should the camp be on a sandy soil, let the trenches be always made on the lee of any sand hillocks; for, if to windward, the light soil will be blown from out of the trench and the dejecta exposed.

Extraordinary care necessary in above particulars.

The greatest attention to minutiæ must be taken in the above directions, for not only is it by the stools that the poison is chiefly spread, but the poison itself is remarkable for its great vitality. Cayley's case shows that the stools may retain their vitality for nine months. Gietl relates a very similar case. A man suffering from enteric, came to a village which had been free from the disease for a long time. His stools were thrown on a dust heap. After some weeks, four attendants, who had at times performed this office, were seized with enteric; their motions were then buried deep in the dust-heap. After another four months, two out of a party of scavengers, who were removing this heap, were seized. This central fact, of the long vitality of the poison, is most important from an etiological point of view, for it explains cases which, otherwise, would be relegated to "the mythical regions of climate and epidemic distribution."

Scavengers.

The mehtars should be camped by themselves. The stools being disinfected directly they are passed, reduces the danger of their contracting the disease to a minimum.

Bed, blankets, &c.

Hospital Precautions.—All soiled blankets, and any bed equipment in use, must be carefully disinfected. Blankets will absorb, and retain with facility, any poisonous material. Enteric fever can be contracted in this way: numerous observers have noticed the frequency with which washerwomen are seized. "A laundress occupied the middle of one of three houses, supplied by one well, into which leaked the slops of the laundress's house. She, on one occasion, received the linen soiled by the discharge of a case of enteric fever, and, after fourteen days, cases occurred in all three houses." If much soiled, the blankets had best be burnt; but, if not, let them be soaked in a solution of corrosive sublimate of the strength of four ounces to the gallon, for two hours; or else in one of chloride of lime of the strength of four ounces to ten gallons of water. At the base, mattresses may be in use; these, we think, should be invariably burnt. No attempt should be made to disinfect such a bulky article as a mattress in a warm climate. But blankets must be economized; as an additional precaution, after exposure to the disinfecting solution, they should be thrown into boiling-water, and remain in it at least half an hour. Finally, all sick orderlies, attending on the cases, should especially be careful as regards soiled clothing.

The tents.

Inasmuch as it is possible some particles of dried excreta may have rested on the walls of the tent, at the termination of the case, wash the surfaces with a solution of corrosive sublimate of 1 in 1000.

Sick attendants.

The attendants must not take their meals, or drink anything, in the hospital tent. Let them always wash their hands in the 1–1000

corrosive-sublimate solution before eating; if their clothes have been soiled by the discharges, at once wash them with this solution.

Can a sick attendant catch the disease directly? Cases are from time to time reported of contagion. Thus, two instances were reported as such from the Khartoum expedition, occurring in hospital orderlies who had been in close attendance, for many days, on men suffering from enteric fever of a severe type. The patients were utterly weak, requiring to be lifted up for the purposes of nature. Now, in these cases, we think, that it is just as reasonable to suppose that the two orderlies caught the disease by their hands becoming soiled, and then infecting their food, or else by their inhaling the poison from the stools, as by direct contagion. At any rate, the possibility is to be borne in mind. Dr. Collie, of the Homerton Field Hospital, has published, lately, a series of papers to show that enteric fever is contagious. In his last paper, he states that, "by contagion, he means communication by direct personal intercourse, in most cases, probably, by means of the recent stools; although it is by no means affirmed that no other emanations from the sick can produce it." No one would object to the first part of the statement; I, personally, however, have never seen any cases leading to the opinion that emanations from the skin of the patient can cause the disease. Dr. Collie's cases are, I think, explicable on the supposition that the attendants contracted their enteric fever either by their hands or clothes becoming soiled, and so their food, or by emanation from the stools; for, although it is most probable that the stools when immediately passed are not infectious, yet it is not absolutely proved; and, moreover, there may be exceptions. Still, cases have occurred of direct contagion, though they are rare. Dr. George Johnson has seen it in two instances in nurses.

Dr. Collie's cases.

Scrupulous cleanliness and disinfection, therefore, are necessary on the part of orderlies; whilst, further, such orderlies for the sick should be as old as possible.

Precautions of attendants.

Treatment of an Epidemic.—The important factor to prevent enteric fever from becoming epidemic is *to recognize the first case.* Beyond doubt, the disease has assumed large proportions in our camps from pardonable failure of diagnosis in this respect. The stools of a mild case are as infectious as are those of a severe one. No better rule can be acted on than that given by Sir Thos. Crawford—viz., "to treat all cases of diarrhœa attended with elevated temperature (fever) as enteric fever until further observation has proved to the contrary." But, with regard to diagnosis, the surgeon should also be on his guard not to swell the returns for enteric by diagnosing cases as such when really they are not present. It must be remembered that all fevers in campaigns tend to lapse into the "typhoid state." The first case of enteric once recognized, I believe that the limitation of the disease is greatly within the power of the medical staff. Should, however, cases increase, at once change the camping ground, and pitch on another well away from it. Should this, for military reasons, be impossible, then all we can do is to see that there is (1) strict

isolation of the sick and their attendants, (2) strict disinfection of the stools and the use of separate trenches, and (3) increase of the superficial space of the camp as much as possible.

Summary.—1. Enteric fever, as met with in tropical and subtropical climates and campaigns, has the same etiology as at home. It is both unnecessary and also prejudicial to the health of the army to wander into "the mythical regions of climate" for its causation.

2. The reproduction of the poison takes place, as in cold climates, in the intestines of the patient. It is then discharged with the motions, and transported, "partly by the patients themselves, partly by their body-linen and bed-linen soiled by the evacuations, perhaps even by healthy individuals to whose clothes or persons the virus may cling."

3. The discovery of the first case is all important. Hence, any case of fever with diarrhœa is to be viewed with suspicion, and treated as enteric fever until proved to be the contrary.

4. To treat as enteric fever, is (1) to isolate, (2) to disinfect the stools, bedding, tents, attendants, clothes and tents, and (3) to increase the superficial space of the camp.

5. To prevent the origin of the first case, scrupulously examine the men before starting, prohibit intercourse with native villages and bazaars, and scrutinize all food, whether solid or liquid, especially looking after the water supply and milk from native villages.

6. There should be a special officer for these duties.

7. Should the disease become epidemic, immediate evacuation of the camp, and the formation of a new one well to windward, is, subject to military considerations, imperatively demanded.

8. Apart from this, striking camp and changing ground in the not immediate neighbourhood should be periodically carried out.

Such are the chief lines to work on.

CHAPTER VI.

TYPHO-MALARIAL FEVER.

THIS is another fever, or rather we have here a fever which is alleged to exist, the description of which, by various authors, is apt to confuse the mind. The main question for us, however, is to judge whether there is any such specific fever as "typho-malarial" fever; if there be, we must then indicate the means of prevention.

The most various meanings have been attached to this term, and the most various views given of its etiology.

The disease was first of all described by Dr. Woodward, based on his experience when serving in the Federal army of the Potomac in 1861. He considered the fever in question as, not a modification of malarial fever, but a hybrid affection—a combination of malaria and enteric. 1. Woodward's views.

The same form of disease has been described more recently by Borelli, of Naples; Aitken, of Rome; Durand-Fardel, of China; and Morel, of French Guiana. But the views held by these of its nature are somewhat different to the "hybrid" view of Woodward; thus—

Borelli looks on the disease simply as a modified form of enteric fever; 2. Borelli.

Aitken as a peculiar form of malarial fever; whilst 3. Aitken.

Durand-Fardel and Morel look on it only as a severe form of malaria. 4. Durand Fardel, Morel.

To myself it would appear that two diseases have been confounded together, and the whole thrown into one class here. The very description itself, given by Woodward, shows this. Thus, Woodward describes the malady as consisting of—

A. A set of cases in which the malarial affection predominated, the disease beginning as a simple intermittent and remittent. "After seven to ten days the fever became continued, or the phenomena peculiar to typhoid showed themselves—diarrhœa, abdominal tenderness, delirium, dry and brown tongue, and the like. Post-mortem showed, as a rule, *only* a simple catarrhal affection of the mucous membrane of the intestines, with accumulation of lymphoid cells in the lymphatic vessels."

B. A set of cases where "typhoid infection was predominant," and the disease took essentially the form of typhoid, and the post-mortem showed in a marked manner the changes proper to that disease.

Now, it is evident Borelli has described and seen class B, whilst Aitken, Morel, and Durand-Fardel have described class A.

The explanation of this form of "typho-malarial" fever is as follows:—In tropical countries we have to start with, first, enteric fever; secondly, various forms of malarial fever.

Class A.—Now, owing to the depression caused by heat, malarial fever in warm countries, when severe, is apt to cause the patient to lapse into an adynamic condition. This is especially the case with remittent fever. In consequence of this, the patient falls into that state the sum of whose symptoms has been designated as the "typhoid state." Woodward himself describes it perfectly in class A. He says: "The phenomena peculiar to typhoid come on from the seventh to the tenth day—viz., diarrhœa, abdominal tenderness, delirium, dry and brown tongue, and the like." But these are the phenomena of the *typhoid state*, not of *typhoid fever* especially. I repeat that the above symptoms are not in the slightest degree peculiar to enteric or typhoid fever; they are to be found in every febrile disease of whatsoever nature, when that specific fever in question becomes adynamic. That this is the case is, moreover, again shown by Woodward, in that he states that "a number of autopsies of this group showed, at the post-mortem, *no other* sign than a smart intestinal catarrh."

Dr. Maury. Dr. Maury, in his paper on the "Fevers of the Mississippi Valley" (in relation to this subject), exactly describes this class of cases. He mentions a form of malarial fever—"the continued." He then states that, in certain cases where the previous condition was bad or the constitution already undermined by repeated attacks of malaria, diarrhœa, dry red shining tongue, sordes, low delirium, with carphology, may be present; in fact, he exactly describes "the typhoid state" as described by Murchison.

Class B.—Class B. of Woodward's "Typho-Malarial," embraces those cases in which "the disease took essentially the form of typhoid, and the P.M. showed, in a marked manner, the changes proper to the disease." Now, why make a mystery, and call this class "typho-malaria"? Surely we have nothing more here than enteric fever occurring in a patient whose constitution is already undermined by repeated malaria, or who, at the time he became infected with enteric fever, was also seized with malarial fever, and thus has both poisons at once in his system. The temperature chart of enteric fever is immensely affected by malaria, but that does not imply a hybrid condition.

Dr. Bartlett. Dr. Bartlett, of America, well remarks that "typhoid fever, like all continued fevers, is sometimes more or less mixed up with, and influenced by, the pathological element of periodicity." Dr. Dr Wooten. Wooten, of Alabama, says, "I may remark that I have often seen typhoid fever complicated with regular remittence; that is, typhoid fever and remittent fever existing together, and I have cured the paroxysmal exacerbations whilst the disease essential to typhoid continued; and I have frequently found it necessary to do this before the more formidable disease could be influenced by remedies." Doubtless, again, the name has been often applied to those cases of enteric fever complicated by malaria in a hot climate, in which the eruption of rose-coloured spots has been

wanting; here there would be the greatest difficulty in diagnosis; but why apply the name "typho-malarial"? Surely, to use the words of Prof. Johnston, of the Columbian University, "the escape from the dilemma of uncertainty by offering a hybrid name to doubtful cases is illogical, because unnecessary and unsupported by any facts which have so far been presented. The conception of typho-malarial fever has come to be a device for easing oneself of the responsibility of accuracy in diagnosis; and gives us no better working theory, as far as practical results go, than we had before." When house-physician at the Seamen's Hospital I had frequent opportunities of observing the manner in which malaria modified the temperature chart of enteric fever. One instance was particularly instructive. Four sailors were admitted on the same day from a ship that had come from Norway. They all had typical quotidian ague. In three of them the paroxysms were subdued in about seven days; but, in the fourth, although the daily intermittent paroxysms were no longer marked, yet the temperature now assumed gradually a more or less remittent, then a continued, type, and soon the rose-coloured eruption of enteric fever appeared, and the man passed through a typical attack of enteric fever. Here, at first, all four patients were diagnosed as simple ordinary ague, till the continuance and change of type of fever in the fourth case showing there was something in addition in his case. Professor Johnston.

Another case, bearing on this subject, terminating fatally, occurred in my experience. Lieut. ——, R.E., was under my care for simple fever, probably from sun exposure. The temperature attained its maximum 103.8 on the fourth day; by the sixth day it had reached the normal, and remained normal night and morning for the next three days. The patient was stationed in the plains, but within four hours' drive of a hill station. I ordered him up to the hills on the morning of the tenth day. The two preceding evenings he had been well enough to go to mess, and continued feeling better except for some remaining weakness. Some few days after his arrival at Murree, he, however, was again seized with fever, which now was diagnosed as enteric, and he died of this from the severe diarrhœa. Now, it is perfectly evident that the first fever attack he had was either malarial or simple, for it disappeared on the sixth day, and did not reappear during the subsequent three days he was under my care; for, as Sir William Jenner insists, a case cannot be one of enteric fever, in which the temperature falls to the normal in the first week. Hence, it follows that there were two morbid influences at work at the same time.

Let us now exhibit the subject as shown in the late Zulu war. "Fever" was very rife at Helpmakaar. Here the garrison was much crowded, without tents, and sleeping on wet mealie bags; and subject constantly to noxious exhalations from decomposing grain and urine in the soil. The fever showed, as one of the clinical symptoms, an absence of correlation between the pulse and temperature. In consequence of the unhealthy state of the Zulu war. Helpmakaar.

Utrecht. camp here, the garrison were sent to Utrecht. Soon after an epidemic of "fever" broke out at Utrecht, and was clearly traced to importation from Helpmakaar. The Natal Carbineers went Dundee. from Helpmakaar to Dundee; the same sequence occurred; a similar "fever" broke out in Dundee.

Nature of this Fever.—There cannot be the slightest doubt that it was enteric fever. The clinical symptom above mentioned, so marked a characteristic of enteric fever, at once separates it from remittent fever. Then we have the evident importation into two directions. Whilst pythogenic conditions (and who can deny also the presence of the specific element) were abundantly present. Yet the term typho-malarial was applied to the disease.

At Fort Chelmsford. After Gingolovo, the camp was shifted to a place named Fort Chelmsford. The site of Fort Chelmsford was very bad and marshy; its water supply organically impure from the presence of a dirty native contingent in its vicinity. Dead bodies of Zulus were to be found in the marshes surrounding it; also those of cattle. Diarrhœa, dysentery, and "fever" became prevalent. At length the sick increased so much that they had to be removed. They were accordingly drafted off twice a week to Fort Pearson, and thence to Durban.

Nature of the Fever.—The cases had all been diagnosed as "remittent" or "bilious-remittent" at Fort Chelmsford. Now Dr. Tarrant, at Fort Pearson, found that they were really enteric fever. The P.M. showed the pathognomonic signs in Peyer's patches. There were also cases of remittent fever; and here any ulceration present was not affecting Peyer's patches. Dr. Tarrant's criticism shows great discrimination.

Galeaka-Gaika. As regards the Galeaka-Gaika campaign of 1877–8, the medical history of the campaign clearly shows, from the reports of three medical officers at different stations many miles apart, that the "fever" was, in the first instance, distinctly imported from outside sources, and at these sources enteric fever was present. These were cases most assuredly either of pure enteric, or enteric fever supervening on malarial fever. Dr. Alcock says, in his account of the fever, that the most remarkable feature was "the want of correlation between the temperature and pulse." Now, there is nothing remarkable at all about this. Any one who has had much experience of enteric fever, knows this clinical fact to be quite common. It was as much the rule as otherwise in all the numerous cases observed by myself at the Seamen's Hospital. Dr. Murchison also draws attention to this point.

Dr. Woolfreyes. Summary. Now, in commenting on the nature of these fever cases, Dr. Woolfreyes, I think, needlessly brings in typho-malaria. He says the cases were either true remittent, or else cases of typho-malaria. He says, also, the latter invariably affects our men in South Africa, instancing the march of the British troops to take possession of the Transvaal in 1877; and the Galeaka-Gaika campaign in Cape Colony. There is, however, not the slightest indication here given us in the medical histories of any other disease than first remittent fever; and, secondly, enteric fever.

As we have shown above, in sub-tropical and tropical climates all fevers may take on a malarious modification, should the patient either have a malarious history or have a coincident attack of malaria; but there is no mystery in it, and no necessity to speak of a new production—typho-malaria. From Dr. Woolfreye's account, there were, in the Zulu war, abundant causes for enteric fever. He speaks, for instance, of the drinking-water contaminated with animal impurity due to the filthy habits of the natives, and the putrefying carcasses of the Zulus and oxen; the animals lying in the water supply, had made their way there in many cases suffering from "lung sickness."

At Quintana the same sequence occurred in the Galeaka-Gaika war. Contamination of water by carcasses of Kaffirs and cattle, followed by enteric fever from pollution of air and drinking water. Pythogenic elements were rife, and can any one deny the presence of the specific element?

Thus, as far as we have gone, we hold there are no grounds for raising to a specific place in our nosology such a disease as "typho-malarial fever." Hence, for the class of cases we have been considering, all we have to do for their prevention is to study the preventive treatment of malaria on the one hand, and that of enteric fever on the other. Summary.

The views of M. Colin we have already discussed on the chapter on Enteric Fever, in relation with the climatic theory of enteric. M. Colin, indeed, disputes the occurrence of any such hybrid disease as is implied in typho-malaria; but his theory of the transformation of malarial fever into enteric is still more unproven and unprovable. M. Colin's views.

Now, although I do not agree with the necessity or propriety of applying a specific name to the class of cases described by Woodward and others we have mentioned, yet there is a different class of fever altogether from these which demands a place in nosology. The admirable paper of Dr. Veale, on "Febris Complicata," describes a disease quite different to the diseases I have been considering hitherto.

Febris Complicata of Dr. Veale.—"This disease has also been named typho-malarial," but *the* typho-malarial of the Mediterranean does not correspond to the typho-malarial fever of Woodward. I place emphasis on the word "*the*"; for in looking over the literature of the subject, it is evident that, under the term "typho-malarial," there have been described by previous authors, not only the fever described by Veale, but, also, cases (1) of enteric fever, modified by the co-existence of malarial fever; (2) of enteric fever in patients who have previously had attacks of malaria; and (3) of severe remittent fever. I am now alluding only to that fever, called typho-malarial, which corresponds to the febris complicata of Veale. In the *Practitioner*, for January 1885, Professor Maclean clearly draws the distinction between all these classes of fever, which have, hitherto, been jumbled together. A large number of invalids had arrived at Netley, from Egypt and the Levant, invalided for various forms Surgeon-General Veale's view.

of fever. Now, Professor Maclean clearly shows that those who came from Cyprus, and had not served in Malta, Gibraltar, or Egypt, were suffering from one or other form of malarial fever. Secondly, that those who came direct from Egypt, without having been to Gibraltar, Malta, or Cyprus, had enteric fever. Whilst, lastly, those who had served in Malta or Gibraltar, had the "febris complicata," of Veale, and the fever especially termed as "typho-malarial," by Maclean. Prof. Maclean, himself, states that he prefers the term "febris complicata" to his own; and, we trust, this may now be the definite term employed. It is evident that here we have a definite affection; one that is certainly not enteric fever, and as certainly not a malarial fever, nor any modification of enteric fever by malaria, or empressment of the taint of malaria on enteric. We have before us a fever which does not yield to quinine in the slightest degree; with insidious access, extremely protracted duration, characterized now by deceptive convalescences, and now by exacerbations, by profuse perspirations which give no relief, by an extraordinary range of complications, affecting all the systems of the body, especially rheumatic, and by a duration which is of months rather than weeks, and which has been known to reach a period of two years. For the full clinical picture, as having no part in this work, I must refer to Dr. Veale's paper; suffice it here to say that the picture drawn is very different to that portrayed by the authors previously alluded to, who have, indeed, not apparently met with this peculiar fever at all.

Now this fever, so far, has only been met with, as regards our army, in Malta and Gibraltar, and as these possessions are half-way to many of the theatres of war, on which we may be destined to fight, it is important to find out the etiology, in order that we may prevent it. But, in truth, at present, its etiology is little more than a matter of conjecture. Dr. Maclean considers there are two factors in it (1) a fæcal, (2) a malarial. But, with the greatest respect to Dr. Maclean, we are unable to find any malarial element in it at all; all anti-malarial remedies have proved quite incapable of alleviating the symptoms of the disease.

Dr. Maclean's views.

Dr. Fite.

Dr. C. C. Fite, of Nashville, in discussing the question of typho-malaria, clearly separated the cases of malaria and of enteric from a different and distinct form of fever. This, he holds, is a separate and distinct disease, due to vegetable decaying matter. He describes the fever as having been brought on, for instance, through drinking water from a cistern in which were some decaying poplar planks. He also refers to cases in the army contracted by the men drinking water that had trickled through a bed of decaying pine needles. This may be one of the sources from which it arises, and the prevention is obvious—viz., to avoid all such drinking-water.

But this etiology will not apply to Gibraltar and Malta. I cannot help thinking some form of fæcal poisoning is at the bottom of it. It is more prevalent at Malta than Gibraltar. Now at Malta we have a porous rock; at Gibraltar, a much less porous

foundation, being of mountain limestone. Until recently, in Malta, the drains were only narrow, deep channels, cut in the soft porous rock. The sewer arrangements are far superior in Gibraltar. The long duration of the disease, and its insidious access, points, without doubt, to some morbific cause slowly, but surely, gaining entrance into the system, and thoroughly permeating it. Now, in both Malta and Gibraltar, and especially in Malta, there is this danger of fæcal contamination of air and water—Malta must be saturated with fæcal detritus. To me, it seems that the constant breathing of a fæcally polluted atmosphere—that is to say, in which the fæcal element exists widely diffused, and is so little concentrated as not to be perceptible by the senses, would result in such an affection.

The improved drainage arrangements now going on should, therefore, be accompanied by a cessation, gradually, of this fever; but owing to the fæcal impregnation that has been going on for years, such amelioration and cessation can be but gradual. Under those circumstances, all troops destined for any war in the East should be camped in the *open*, and not in barracks, in Malta and Gibraltar; and the conservancy and drinking arrangements must be conducted with the greatest precaution.

Summary.—1. There should be, for the future, complete "blotting out" of the name "typho-malaria."

2. There are no such diseases as either (1) a hybrid of enteric and malaria; or (2) a transformation of malaria into enteric. The disease to which the name of "typho-malarial fever" has been applied by authors holding the above views, are either severe forms of remittent fever lapsing into the typhoid state, or else enteric fever (1) modified by its occurrence in a patient who had previously suffered much from malaria, or (2) occurring simultaneously with an attack of malarial fever.

3. There is a peculiar and distinct disease, also, which has been designated typho-malarial fever, perfectly distinct from the above. It is best described as "febris complicata." Its etiology is unknown, but it is most probably connected with persistent fæcal impurity of the atmosphere, and perhaps of the drinking-water. It may also be due to drinking water rendered impure by decaying vegetable matter.

CHAPTER VII.

RELAPSING FEVER.

The proofs that this disease exists in the tropics and sub-tropics are now abundant. It has been described as existing in Egypt, Nubia, Abyssinia, Algiers, in the Mauritius, in India, and China.

At first sight it would appear to be superfluous to include this fever in the list of diseases to which our troops are liable in tropical and sub-tropical campaigns, so intimately is its etiology connected with famine. It is true that military epidemics of this fever in warm climates have been for many years unheard-of. Of late years greater attention has been paid to the soldier's diet. Hence the disease is not likely to arise amongst our troops. But in a campaign we have another class to provide for—viz., the camp followers—and amongst camp followers a notable instance occurred in the Abyssinian campaign. Now, the fever is distinguished by its great contagious powers; hence, it is imperative in us to look after our camp followers in this respect. "The camp follower's ration" is of equal importance to the "soldier's ration." In a campaign in the hills in India, in Egypt, in Afghanistan, we could not move without our camp followers, and they must be, therefore, provided for, if only from the selfish point of view of self-interest, with forethought equal to that we bestow on the fighting-man.

We, however, do not hold that only "famine" can produce, *per se*, this fever, but that its ravages are greatly favoured by want of food is evident.

One of the most comprehensive works on relapsing fever, as it occurs in India, is that by Surgeon-Major R. T. Lyons, of the Indian Medical Service. Unfortunately, he has proved too much; he has included under relapsing fever such diseases as relapsing attacks of, and ordinary, intermittent and remittent fevers. It is true he denies altogether apparently that there are such fevers as malarial intermittent, and remittent. He has thus gone to the opposite extreme. Doubtless, many fevers have been returned as malarial which are not malarial. But we find Dr. Lyons stating that Peshawur fever, ardent continued fever, jungle fever, &c., are only synonyms for relapsing fever. In his historical summary it is manifest that a very large number of his cases are but cases of severe remittent and intermittent fevers. There is absolutely no evidence that the form of fever from which, for instance, H.M. 89th Regiment suffered on active service in Burmah in 1824 was relapsing fever; on the contrary, it was clearly a

malarious fever. Dr. Rankine states: "the men bivouacked on the ground for several days and nights; the consequence was that a great number of the soldiers were attacked with remittent and intermittent fevers of the most malignant forms I ever witnessed." Now what is there in this description, or the context, to warrant the assumption that Dr. Rankine made a wrong diagnosis? Dr. Rankine says the fevers were remittent and intermittent distinctly.

Goomah and Kimedy expedition, 1833.

In 1833, however, relapsing fever appears to have affected our troops operating against the hill tribes of Goomah and Kimedy. The description given by Dr. M'Donel tallies with what we know of the disease now: "relapses were very common, many occurring after the individuals had been freed from fever for upwards of fifteen or twenty days." The troops were subjected to great privation of diet, for Goomah was without supplies of any kind, and the supplies coming in from Kimedy were at first cut off by hill-men; when they did come in, the allowance was insufficient; the rice was bad, and there was a total privation of the usual condiments.

Scinde campaign, 1843.

In the Scinde campaign of 1843, a fever appeared attacking the men suddenly. Amongst the symptoms characteristic of relapsing fever that occurred may be mentioned bilious vomiting, epistaxis, amaurotic affections and complete intermission, followed by relapse. It was termed "bilious intermittent" by Dr. Carter, of the 21st Bombay N.I., who observed it. This "awful epidemic" affected all the troops collected at Haidarabad after the battles of Miani and Haidarabad. "The native regiments were quartered in the deserted houses and villages of persons who had either perished in action, or with their wives and families had fled from homes no longer welcome to them under the dominion of a foreign power." There is no history, however, of any fever prevalent amongst the inhabitants previous to their flight. Still we think the evidence points that the fever in question was relapsing fever. All the medical officers and hospital establishments were at one time or other attacked by the fever, showing, at any rate, the contagious nature of the disease.

Abyssinian war, 1867–8.

An undoubted outbreak of relapsing fever occurred in connection with the Abyssinian war in 1867–8. The outbreak occurred amongst the Punjab muleteers. During the passage from India to Abyssinia these had enjoyed perfect health, and they remained well during the first part of the campaign. However, they then began to suffer to a large extent from "remittent fever" at Zoulla. This fever was marked by jaundice. At first the cases were sporadic, only affecting a detachment of the mule-drivers. The main body of the muleteers having returned to Bombay before these cases, they waited for them there. On the arrival of their sick companions, the main body became affected. They were taken up the Indus to return to their homes, and infected the boatmen. There is no mention in the medical history of the Abyssinian war of any fever amongst the natives; but, if we believe in the spontaneous origin of the disease, we find plenty of

causes in their bad and insufficient food, improper cooking, exposure to vicissitudes of temperature, &c. From the date of leaving Bombay till they left quarantine in Mooltan and Lahore, out of 4500 men 404 died. Again, a similar outbreak occurred amongst some of the dooly bearers who went on service with the Abyssinian force. In the ship *India*, which sailed from Calcutta on December 6, 1867, with 419 Kahars on board, and arrived at Aden on January 4, 1868, 46 died during a passage of thirty days. Two of the crew also died. On arrival at Annesley Bay, five days aftewards, 87 of the bearers and 3 of the Lascars were ill. Three of the crew died. The deaths were all due to the variety of the fever—"bilious typhoid"—that proved so fatal to the returning muleteers.

A similar outbreak occurred amongst a party of bearers returning from Abyssinia in the ship *Ophir*. Out of 422 men who embarked at Zoulla on June 2, 1868, 27 died before reaching Calcutta on July 23.

Looshai. 1871–2.

The disease again appeared in the right, or Chittagong column, in the Looshai war, commencing in the coolie corps attached to that column. As observed in the general hospital at Kasalong, the fever lasted from five to ten days, followed by a period of convalescence, which might be permanent; in the majority of cases, the fever recurred within four to ten days, the relapse was milder as a rule, lasting three to eight days; occasionally there was a third relapse, sometimes a fourth and fifth. The mortality was slight, out of 371 cases, only 4 deaths occurred amongst the camp followers, and none at all amongst the Sepoys. It was very contagious, attacking all the hospital establishment except three men. It also attacked some of the Sepoys, and men of the Sappers and Miners. Of the Europeans attacked, only those were affected who were brought into close intercourse with the coolies—the chief sufferers. This fever did not exist in the Looshai villages, but Dr. Lyons, who observed it, believes that it was imported by the coolies from Lower Bengal as follows:—During the latter half of 1871 a destructive epidemic fever raged in Lower Bengal and Burdwan, identical with an epidemic in Lower Bengal in 1870. Now, the coolies were raised in the affected districts, and, it is believed, conveyed the disease across the Bay of Bengal to Chittagong and the hill tracts. These Bengalee coolies proceeded to Burkul, where they were stationed, and Burkul was the head-quarters of the fever. The limited extent of the epidemic in the force was due to the good food and open-air life.

Ashanti, 1873.

Great precautions were taken in Ashanti, as the disease was believed to be rife amongst the natives. It was recommended as a "vital sanitary precaution," not to bring any of the prisoners amongst our troops. As a matter of fact, no outbreak did occur. The precaution may truly be called "vital," for the fever once started is superlatively contagious, and if once it spread to the fighting element, we can well understand how the latter would become crippled.

From this recital, it is evident that relapsing fever is liable to

arise amongst our camp followers, and from them to spread to our troops. Hence, for the protection of our troops from the attack, we have, imprimis, to deal with the prevention of the disease amongst our camp followers.

The French have likewise experienced this disease. It raged greatly amongst the wounded in Egypt after the battle of Heliopolis and the siege of Cairo in 1800. The form of the disease here was also that known as "bilious typhoid." This is "the highly congestive form" of Cormack; it is comparatively rare, but often fatal, but that it is of the same nature has been proved by the discovery in it of the specific spirillum. In this epidemic in Egypt, 200 out of 600 died. Again, Morache has experienced the fever in China. Relapsing fever in other armies.

Etiology.—Few facts now are more definitely established than the relation of a specific organism to the disease. The spirillum was originally discovered in 1873 by Obermeier. Since then he has been confirmed by many other observers. Moschutkowsky 1876, 1879, 1880), first, by inoculation, produced the specific fever in men. He also proved the identity of the so-called "bilious typhoid" with relapsing fever, by discovering in the former the spirillum. Vandyke Carter communicated the disease, by inoculation, to monkeys. Carter has, moreover, always been able to detect the parasites some time before the rise of temperature in the relapse; in his later observations, by newer and improved methods, he has invariably found them in the blood throughout the whole febrile stage, and he has found them vanish with the disappearance of the fever. There can be no doubt now, that in relapsing fever we have, as an exciting cause, therefore, the spirochete Obermeieri. 1. Specific.

In 1879–80 an extensive epidemic occurred at Konisberg. 360 cases were admitted into the municipal hospital, in almost every case the spirilla were found during the attack.

Can, however, relapsing fever spontaneously arise? Can it arise *de novo?* Dr. Murchison was of the opinion that it could be generated by destitution alone. Dr. Lyons seems to agree with this. However, many of his cases are not relapsing fever at all, and, secondly, contagion has not been sought for. I, myself, believe that mere destitution will not generate the fever, nor will mere unhygienic conditions, though, when once started, these two conditions will immensely favour its spread. Destitution simply acts by weakening the organism, and so rendering it less able to resist the specific spirillum, whilst bad hygiene prepares, as Hirsch tersely puts it, the soil for the spread and development of the disease. In many epidemics in England there has been no destitution at all, whilst the converse is shown by Lyons himself to be true, both as regards the civil population of India, and expeditions of war against hill tribes, or in the old Sikh wars. The German physicians who saw the disease in 1868 and 1872, do not believe in destitution as a primary excitor. 2. Spontaneous

Selection of Men.—From what we have seen concerning the origin of the epidemic in Looshai, it is evident that we must

exercise great vigilance in the selection of our coolie and camp followers, and must exercise precaution in seeing that no such disease exists amongst any that are selected. The fever is evidently far from uncommon in many parts of India, and it affects just that class from which camp followers are drawn. Both in tropical and sub-tropical climates, the destitute and lower orders are the predisposed class, as they are in temperate climes. Griesinger, in Egypt, has seen the disease only amongst the lower orders, amongst labourers, soldiers, and the like. In Réunion, only the negroes, coolies, and natives living in crowded and filthy huts, suffered; the whites, living in comfortable circumstances, were quite exempt. In Abyssinia, again, the disease was limited to the muleteers. Thus, the danger of any epidemic starting in an expedition resides in the selection of coolies, camp followers, &c., already infected. Again, as regards other points in selection, we should choose as many of our camp followers above the age of twenty-five as possible, as, according to Murchison's statistics, the age chiefly affected has been from fifteen to twenty-five years.

Selection of Season.—As regards the factor of season, the disease has no relation to it, or to any meteorological influence whatever. It has prevailed alike in all seasons, and under all circumstances of weather.

Marching.—As predisposing to the disease, it must be borne in mind that bodily fatigue exercises an influence favourable for the reception of the disease. To this, Dr. Lyons partly attributes the wide diffusion of the disease in the Scinde campaigns, and in the Kimedy and Goomah epidemics; wet and exposure act in the same way. The mere mention of these factors will therefore suggest the preventive measures which must be undertaken.

But further, as regards the housing of the coolies proceeding up streams in boats towards the scene of conflict, we have to particularly insist on the great necessity of providing against overcrowding. Sufficient cubic and superficial space must be allowed. This is especially to be the case in campaigns on the north-east frontier of India, where our coolies will be drawn probably from districts especially liable to be infected. In the epidemic occurring in Algiers, Arnould drew special attention to the agglomeration of a large number of human beings in one place, and the consequent vitiation of the air.

Baggage animals.

Finally, Lyons considers that the baggage animals are capable of generating the disease, and communicating it to the men. This we believe to be a mere expression of belief, all evidence points to the contrary; experiments on animals other than monkeys have never succeeded; inoculations on dogs, for instance, have failed at the hands of Moschutkowsky and Koch, yet Lyons states they have contracted the disease from man; we fail, however, to find any evidence of this in his work, and therefore doubt if baggage animals can be a source of the disease to our men.

Ration to be equivalent to

Food.—It is needless to insist on the extreme importance of giving the coolie on expeditions of war a ration equal to his

work; yet in reading the histories of past campaigns it is evident that this has not always been the case. Our soldiers are not likely to suffer from the effects contingent on an insufficient ration in the future; the epidemics in the Kimedy and Goomah campaigns spread so largely however from deficiency of food, especially in relation to the great fatigue undergone, the disease having arisen amongst the destitute conquered enemy; it spread to our troops, and was largely aided in its spread by the breakdown of our commissariat (Lyons). But, as we have before stated, it behoves us to care for the coolies' ration equally as for the soldier; the camp-followers, baggage-men, coolies, &c., in tropical countries constitute a vital factor; if this factor break down, how can the fighting element advance? Therefore, we think, an issue of meat at least twice a week should be arranged for the meat-eaters of the coolie corps equally as for the fighting element, and on non-meat days, ghee and goor, with atta, &c., should be allowed, and, finally, a vegetable ration added. The remarks made on vegetables in the chapter on Scurvy are applicable here, for there is much evidence to show that the scorbutic state predisposes to relapsing fever (Murchison, Lyons). Finally, as regards a pure water supply, this must be attended to also as regards relapsing fever; from the experience of epidemics, Lebert has found impure and stagnant drinking water highly favourable to the spread of the disease.

work done and fatigue undergone.

Water.

The Camp.—There are no influences exerted on relapsing fever by the soil, altitude, or geology. Soils especially held to be malarious exert no influence. The disease has been stated to be due to malaria; but this cannot be so. Why should it attack the destitute at its origin? Also, the disease is equally prevalent in all seasons—in the hot, rainy, and cold. It is also endemic in countries where there is no malaria. Again, relapsing fever, imported into Réunion from India, broke out at a time when that island enjoyed a complete immunity from malaria, and, moreover, it died out just as an intense focus of malarial fever developed.

Carter has attributed the disease to irrigation; however, many facts tell against this view.

But *the* factor in camps is overcrowding. Here, again, we would urge that the camps be spread over as wide a space as is consistent with military precautions.

Treatment of an Epidemic.—Having now completed our survey of the chief predisposing elements, I proceed finally to indicate the measures to be undertaken to prevent the spread of the disease when once it has arisen. The chief element to be combatted is the intense communicability of the disease.

First, the hospital tents should be as widely separate as possible, and with the freest ventilation. Should the sick be isolated? Lebert holds that isolation is not necessary, provided there be free renewal of air. Litten, however, insists on the contrary; and it is curious that he brings statistics to support his opinion gathered from the same epidemic at Breslau as that from which Lebert speaks. My own experience of relapsing fever has been limited

Free ventilation of camp.

to civil life; here the cases were treated promiscuously in the wards of King's College Hospital without any spread to the other patients. In war, however, I think the conditions are altered; here one may not be able to obtain the same amount of ventilation for each sick man as in a civil hospital; hence, not only should the camp followers (among whom the disease will originate) have their own special hospital tent, but the cases must have also their own isolated tents. The disease is not likely to spread to the fighting element; our chief efforts must be directed to keeping it within bounds amongst the followers.

Isolation of sick.

Disinfection.

Clothing.

Bedding.

Excreta tents.

Nurses and hospital establishment.

After isolation, we come to disinfection. The disease is peculiarly liable to spread by soiled clothing; hence, as soon as any clothing is done with, throw it into boiling water, or disinfect it by corrosive sublimate solution. Cormack, as the result of his experience in the epidemic of 1842 at Edinburgh, remarked that "the clothes of our fever patients are special repositories and communicators of the morbid poison." Bedding must be likewise disinfected. According to other observers, the excreta must be especially disinfected. The means have been already indicated. The hospital tents must be similarly treated. Wyss and Bock state, from the Breslau epidemic of 1866, that the morbid poison clings for a long period of time to rooms that have been occupied by the sick. Finally, the hospital attendants must take, on their part, the precautions already indicated in preceding chapters, to prevent their own infection, and they must *limit themselves strictly* to these cases when once they have undertaken their care. For even healthy persons living with relapsing fever patients may carry the poison. The great infecting power of the poison is *the* fact to bear in mind; it was shown in the Scinde, Goomah, and Kimedy epidemics, in the infection of the boatmen conveying the Punjabi muleteers up the Indus, after their return from Abyssinia, and in the large number of cases that have occurred in the Indian gaols. This infecting power is also shown by the numerous instances of infection of the hospital establishment. Dr. Lyons quotes for instance an epidemic that occurred in the 20th P.I. at Rawal Pindi in 1864. Here, out of the establishment of the hospital, "one of the two native doctors, the hospital havildar, all of the four dooly bearers, both of the bheesties, both of the cooks, and both of the mehtars contracted the fever, as well as the mother and younger brother of one of the latter, who resided on the premises, and helped in the work of the hospital; so that of the entire hospital establishment only two escaped—a native doctor and myself." This fact of infection must be borne in mind by all who come into contact with the sick. In Looshai, Lyons shows how the commissariat staff-sergeants, telegraph, and survey officers, who had unavoidably to associate much with the coolies, were the chief sufferers of the Europeans attacked.

Antiseptic "rations."

Antiseptic "rations" of quinine, and salicylate of soda have been tried, but have hitherto failed. Indeed, if given to an actual patient, it has been found that neither remedy has any effect on the parasites in the blood.

Example of Treatment of an Epidemic.—In conclusion, I will briefly state the means employed to control and stamp out the epidemic amongst the Punjabi muleteers. On their arrival at Mooltan they were divided into small, separate camps, each with its own hospital, so as to prevent communication as much as possible with the main camp. Each detachment also was separated from the rest. All patients as they were discharged were sent first to a convalescent camp for ten days before finally mixing with the outside world. Their clothing and bedding were boiled and washed. By these admirable means of isolation, Dr. Gray, of the Indian Medical Service, succeeded in stamping out the epidemic.

CHAPTER VIII.

TYPHUS FEVER.

In none of our sub-tropical or tropical campaigns has typhus fever played a part, nor is it likely to. In itself, it is a disease chiefly of the temperate and cold zones. It is, however, found in sub-tropical climates; but the purely tropical regions seem to be exempt. In the French war in Mexico and in Peru, for instance, the uplands and high plateaus were the regions chiefly affected. Still, we must remember that it is to be looked out for in sub-tropical regions. Our surgeons were warned concerning it during the operations of war in Egypt; it is endemic in Nubia; in 1868 there was a great epidemic in Tunis; in Algiers it, from time to time, became epidemic under "peculiarly unfavourable states of hygiène;" and, in view of the Central Asian Question, it is well to point out that, on Asiatic soil, its headquarters are in Persia, and that it has occurred epidemically in Asia Minor. As regards India, epidemics of typhus have been described as occurring which were really relapsing fever—for instance, the epidemic of 1859–61 in the N.W.P. and Punjaub. Chevers would seem to have been mistaken when he states it is unknown in India. In 1869, Dr. Lyons described a fever epidemic occurring in the Rawal Pindi Tail. There was here overcrowding. The fever had a mulberry rash, was very contagious, and amongst its clinical symptoms were constipation and buboes. There were no relapses. In fatal cases there were no intestinal lesions. Its duration varied from seven to fourteen days. This fever was most undoubtedly typhus.

Now, it would imply a want of hygiene almost inexcusable if such a state of affairs were to exist in a force as would bring about typhus. Professor Du Chaumont has, indeed, stated, in his lecture on military hygiene at the Royal United Service Institution, that "in time of war the disease is always to be feared." But, as he rightly says, that two conditions—viz., "crowding and destitution" —must be present together to give rise to, or to favour, the propagation of the disease, I cannot agree with him that it is now-adays a disease always to be feared. Surely such a factor as "destitution" ought never again to enter; and, as regards "over-crowding," unless a British army were closely besieged, which is not likely to last, at any rate, any time, the factor of "over-crowding" will not enter. Hence, it is unnecessary to treat, in detail, of the effect of criminal sanitation. The only danger of typhus ever attacking our troops in sub-tropical campaigns lies in infection from native sources. And infection ought never to

arise; for the intelligence department would surely gather information whether typhus were epidemic in any town or village near which our forces may be encamped. It is therefore unnecessary to enter into the subject at greater length than will suffice to indicate the lines of prevention to be followed should ever our army approach a focus of typhus. A few words, therefore, on the etiology of typhus.

Etiology.—Typhus fever is independent of all telluric conditions: the factors predisposing are, want, filth, overcrowding. No race is immune. It occurs at all seasons. As regards its primary origin, we know nothing as yet definite concerning any specific contagium, for, although Dr. Mott, at the meeting of the British Medical Association, in 1883, described a parasite, the question is still *sub judice*. Murchison champions the autocthonous origin out of wretched conditions of living. In war, the disease has occurred most frequently in besieged fortresses, as in such condition the factors of overcrowding and privation come into play. We can find no instance of typhus in warm climates in the campaigns detailed in the A.M.D. Reports. In China, however, in 1863, the above factors came into play. During the Taeping rebellion, the town of Shanghai, containing about 600,000 inhabitants, served as a place of refuge for the inhabitants of the surrounding country from the pursuit of the rebels. The number of refugees was estimated at about one million. Undergoing all kinds of privations, they succumbed in great numbers. The streets were encumbered with corpses, and soon an epidemic of typhus developed. Here, then, were all the conditions at hand for the development or furtherance of typhus. Again, during the siege of Lima in 1821, and of Callao in 1825–6, typhus arose. In the pre-sanitary age, doubtless, typhus might have arisen during our wars in Natal and the Transvaal in 1881. Standerston, Wakkerstroom, Potchefstroom, Fort Mary Lydenburg, were all closely besieged; the men were on reduced scales of rations. At Potchefstroom, 305 people were shut up in a fort twenty-five yards square, with scanty supplies of food and water; yet in all the health remained good. And that this result was obtained was due to the unremitting care and attention paid to sanitation by the medical officers. Drains were dug, all refuse burnt, and conservancy rigorously attended to. Thus, even under the most unfavourable circumstances, the origin of typhus can be prevented by strict attention to sanitation.

To Prevent Importation.—Importation, however, may come into play as a factor. In the first place, should a contagious fever be found to exist in any village or town on the theatre of operations, all intercourse with such will, of course, be prohibited. And this will especially be the case when the bazaars of the place offer opportunities for purchasing intoxicating liquors, for it is needless to say intemperance greatly predisposes. Especial attention must be paid to the drinking-water on such occasions, and its relation to the infected locality observed. Parkes, indeed, states that it is not known to be communicated by water; yet Lebert

No intercourse with affected locality.

Drinking-water.

warns us that the poison of typhus readily accumulates in the stagnant ground-water, and thence passes into the air and drinking-water. He, in his monograph on "Typhus," states that "Posen is one of those places where typhus is of frequent occurrence, but seems to have become much more rare since the improvement in the distribution of water." Hence, the source of the water supply should have no connection with the infected focus, and the water itself should be purified, as already laid down in the earlier portion of this work.

Transports.—That the greatest attention must be paid to the hygiene of transports is evident from the following facts:—In Sir Robert Wilson's account of the Indian contingent in the expedition to Egypt in 1801, certain companies of the 61st European Regiment were detained at the Cape in consequence of "gaol fever" having broken out in the *Sheerness* and *Wilhelmina.* The ships were then made so healthy by cleansing and fumigation that no further sickness occurred. Again, during the French war in Mexico, a regiment of 447 negroes were recruited in Egypt for service, and embarked on the *Seine.* Typhus broke out. M. Fugier, the historian of this epidemic, points out that the epidemic arose from the vitiation of the air of the lower deck where the men were located, and general want of hygiene. There were no portholes. During the preceding voyage of fifty-two days, the same ship had been loaded with mules and horses, and the latter had made the vessel extremely dirty. Again, in 1861 and 1864, two Egyptian ships of war were the cause of an outbreak of typhus. These vessels, proceeding from Egypt to Liverpool and Toulon, were greatly overcrowded and very filthy between decks, and typhus arose. Pringle and Lind likewise draw attention to the origin of the disease in this fashion. The above facts indicate at once, therefore, the necessary precautions of good hygiene and free ventilation in the transports.

The Camp.—There must be the greatest ventilation and dispersion of tents possible. In the field this is the chief point. All observers insist on this. Roth and Lex, for instance, say that, in the field, the chief care must be for pure air. Murchison states that "typhus fever, which, during warfare, often commits greater havoc than the sword of the enemy, may be prevented by plenty of fresh air and personal cleanliness." Baudens gives a striking example of the necessity of good hygiene in the camp. In the Crimea, two regiments were encamped side by side. With one, hygiene in all points was perfect; with the other, the reverse obtained, and typhus broke out. Again, in 1868, in Algiers, in consequence of famine, the Kabyles flocked in crowds to the towns for food. Great overcrowding occurred, and a typhus epidemic broke out amongst them. In the War of the Secession in America, typhus occurred in the Southern force, but only in those camps that were overcrowded and badly conserved.

The sick.

Should, however, typhus be brought into camp, the cases must be at once isolated to leeward. The hospital tents must be opened as much as possible. It should be remembered that the actual

distance that the contagion entirely travels in the air from the body where there is good ventilation has been stated to extend not further than one foot from the patient. And again, most authorities agree that there is very little power of infection during the first week; hence, we see, we should at once isolate, and freely ventilate. At the same time a number of typhus patients should not be aggregated together; there must be isolation without aggregation.

In a base hospital, where it would be advisable to have separate wards for the typhus patients, there must, however, be a certain amount of aggregation, in that it would be preferable to treat all the typhus patients together, and not to disperse them amongst the others. However, I have never seen typhus caught by one patient from another when placed in a general ward.

Nitrous acid fumes have been recommended for diffusion equably through the ward, should the hospital be located in a building. It is needless to say that the strength must be very dilute.

Conservancy.

Many authors think contagion can occur by the stools. Hence, the measures indicated under enteric fever must be adhered to. Roth insists on the excreta being disinfected, as carriers of the poison.

The attendants.

The attendants on the patients are extremely liable to become infected. The experience of all fever hospitals shows this. In the epidemic in Algeria in 1867, the general mortality from typhus in the army of Africa being 3.64 per 1000, that for the hospital staff was 15.8 per 1000. Hence, it should be a standing rule that the attendants on typhus patients be absolutely restricted to them. Ordinary measures, such as cleanliness and feeding, must be attended to. An attendant should never begin his duties on an empty stomach; nor should he eat his food in the tent; nor should he sleep in the hospital tent. As far as circumstances permit, there should be relays, so as to enable each man to obtain a fair amount of fresh air. They should daily wash their clothes, and have a change, or, at any rate, beat them in the air. It is here that the chief danger of typhus, once brought into camp, becoming diffused, lies. Those in close attendance on the sick incur the danger to the highest degree. This was shown in the Crimean war, in which eighty French surgeons were infected with typhus (Roth).

Convalescents

Men convalescent should not join their comrades at once. They must remain apart for at least fourteen days, if circumstances will not permit their being invalided at once. Of course, a man who has had typhus will not be of any further use for the campaign without sick leave to set him up; but should he not be able to go away at once, he must, as we say, at any rate, not mix with his fellows, for the contagion still exists during convalescence.

Death.

It is not settled whether the body, after death, can carry contagion. The probability is that it can. At any rate, Murchison seems to have caught his first attack in the dissecting-room. The body should preferably be burnt; if not, it should be enveloped

in a covering saturated with the strong solution (1–500) of corrosive sublimate, or a 5 per cent. solution of carbolic acid, or a 4 per cent. solution of chloride of lime.

Disinfection of hospital.

The tents must be especially looked after. Thus, Pringle gives an account of twenty-three persons who were employed in refitting old tents in which typhus patients had lain, seventeen of whom died of the infection. Freely, therefore, expose all tents to the air, and then wash them with the corrosive-sublimate solution of strength (1–1000). The bedding and blankets had best be burnt. The dark woollen soldier's blanket must be full of the poison by the time the patient is convalescent; for the texture is that most favourable for absorbing and retaining exhalations; whilst Haller, of Vienna, has shown how dark colours attract the poison more than light. He has pointed out that convalescents joining their regiment with dark uniforms are more liable to bring infection than those convalescents whose uniforms are of light colour. Hence, always burn the blankets. Finally, disinfect thoroughly the clothes of the patient.

Golden Rule.—In conclusion, should typhus ever be brought into camp, the fact to be remembered is that free ventilation—free perflation of air—is to be primarily insisted on. Let the camp be "dislocated" as far as is compatible with military precautions, for whilst the poison of typhus is intense where there is overcrowding and bad ventilation, it is almost *nil* under the opposite conditions.

CHAPTER IX.

THE PLAGUE.

THE question of the prevention of plague was brought to the front in the operations of war in Egypt in 1882, in that the medical officers were warned that they might have to deal with it. Plague, however, was not met with in this campaign. Our troops, however, were not so fortunate in a former campaign in Egypt, that of 1801, 1802; but the excellent preventive measures then instituted kept it in abeyance. "If," says Sir James M'Grigor, "in the treatment of the disease, we were not successful, we assuredly were completely so in the prevention. At length, this became so generally known, that we no longer heard the distressing accounts of despondence and despair among the natives." He here alludes to the native troops from India, who, from a state of great despondency, ended in furnishing volunteers for duty in the hospitals set apart for plague. If, in 1801, medical military science was successful, it should be far more so now, even, we think, up to the point of completely preventing its importation, at the present epoch.

The geographical pathology of the disease warns us that we may meet with it in military operations. Recent outbreaks have occurred in the north-west of Persia in Aserbijan and in Kurdistan in 1863, 1871, 1878; in Resht (Gilan) 1877–8. In China, again, an epidemic occurred in 1871–2, said to have been imported from Burmah. In the *Illustrated Naval and Military Magazine* for August 1885 it was stated that in the event of England taking part in the late Russo-Turkish war—operations would have involved occupation of Baghdad, and the employment of Kurds.

Again, although plague has not been seen in Egypt since 1844, nor in Asia Minor since 1839, yet many authorities, such as Gavin Milroy, looking to the long intervals which have been observed between recurring epidemics of the disease, doubt its cessation. These doubts, moreover, according to Netten Radcliffe, were confirmed by the reappearance of the plague in the Levant in 1853, nine years after the assumed cessation of the disease in Egypt.

Etiology.—Plague is undoubtedly of near blood-relation to typhus. Indeed, it is doubtful if they are really not one disease. A case of plague chosen from its outer limit may differ from a similarly chosen case of typhus; but as we approach the cases of both diseases merging towards a common boundary-line, the similitude is so great that many hold that typhus in cold climates

answers to the plague in the East. Murchison relates, that when Clot Bey, an Egyptian physician, visited the London Fever Hospital, he, on seeing cases of typhus complicated with parotid buboes, at once declared that they would be regarded as examples of plague in Egypt.

In 1844, a Commission of the French Academy of Medicine drew up a report, setting forth the local conditions favouring the development of plague. These were marshy and alluvial soils, warm and humid atmosphere, absence of, or ill, ventilation, accumulation of putrifying animal and vegetable matters in the vicinity of dwellings, unwholesome and insufficient food, and neglect of hygiene generally. Now, with the exception of the statement concerning soils, the above conditions are correct. But, with regard to soil, marshy and alluvial sites, by no means are especially related to plague. The disease has occurred in elevated regions, in Syria, Algiers, Persia, Arabia; indeed, it would seem that elevated localities are more predisposed to it than a low plain. The geological characters of the soil have no influence. Hirsch points out that, so far from the soil of the Nile Valley being a classical plague soil, the disease has developed just as freely on the dry, barren soil of Kurdistan. In Asia, again, it affected the regions free from marshes, whilst the neighbouring swampy plains were exempt. The real great factors in plague are comprised, generally, under neglected hygiene.

As regards any specific organism, nothing has yet been ascertained; but if, as is most probable, there be one, it will not flourish without the want of sanitation indicated. Hence, the prevention of plague consists, in a great measure, in the prevention of want of sanitation, as far as its epidemic and widespread onslaught is concerned, whilst, as regards its primary importation, we have to guard against the factor of human intercourse.

Finally, in the matter of etiology, sub-tropical, rather than tropical, climates are favourable to the location of plague.

Selection of Season.—Both Laveran and Hirsch state that mean temperatures are favourable, and extremes unfavourable, to plague. In Egypt, in 1801, the first case occurred in the middle of September, and the disease lasted all through the cold weather. M'Grigor states that, for Egypt, the recognised cycle is from November of one year to the June following; and, thus, the period generally most favourable for campaign, is unfavourable as regards plague. But the statistics, collected by Hirsch, of deaths from plague in Alexandria, from 1834–43, agree with M'Grigor's dictum, as seen in the following table of the total deaths in the respective months for these years:—January, 329; February, 1112; March, 4952; April, 2936; May, 1799; June, 547; July, 216; August, 100; September, 15; October, 18; November, 63; December, 195.

The Camp.—As we have seen, the nature of the ground on which the camp is pitched exerts no influence, but the point to be insisted on is, sanitation. Sir Robert Wilson's remarks on the plague in 1801, in Egypt, fully show the conditions constituting

hot-beds for plague. "A Turkish market," he says, "is sufficient to generate a plague; it is never cleaned. Rosetta is infested with filth, mosquitoes of the most dreadful kind, vermin of every sort; with stench intolerable, houses almost uninhabitable, the air so tainted and oppressive" as to turn English visitors away in disgust. "The camp of the Grand Vizier, at Balbeis, was a disgusting chaos, with dirt and filth enough to generate the plague and every pestilential disease." Now, although by the excellent preventive measures enforced by the medical chiefs, in Egypt, in 1801, success in limiting the infection was attained, yet it must not be supposed a limited outbreak of the plague only was present at the time, in Egypt. The year 1801 was, on the contrary, a bad one for plague. The Mamelukes had suffered severely, 60,000 of the people having died of the disease in Upper Egypt, whilst 40,000 were attacked in Cairo. An intercepted letter from General Belliad showed that, in six days, 150 soldiers died of it in Cairo. At El Arish, the garrison of native Egyptians was reduced by it in less than a month, from 4000 to 1500. Contrast these experiences with the results gained in the Anglo-Indian force. Here there were only 38 deaths amongst the Europeans, and 127 amongst the native troops, out of a force of 7886! 1. Sanitation.

The camp measures to be followed out are comprised under three heads—(1) free ventilation; (2) "dislocation" of the troops; and (3) conservancy. These factors have already been fully entered into, and need not detain us. By these factors a sanitary camp can be obtained, and even if imported the disease will gain no foothold for an epidemic. Over and over again in the histories of outbreaks of plague is the want of sanitation insisted on. For example, in the large epidemic in Kurdistan in 1863, the infected district was pervaded with the putrid emanation of unburied cattle that had died from murrain. Dr. Murray, when writing on plague in India, states, "all the medical officers concur in the dissemination being essentially promoted by crowding, bad ventilation, and defective sanitary arrangements." Especially, therefore, must the sanitary condition of the camp followers be supervised. And, lastly, it is very important to avoid all buildings for lodgment in any locality where plague has been known to exist. 2. Camp measures. 3. Avoid former foci.

Importation will occur probably mostly from camp followers. Our men also, after a victory, by visiting the camps of the enemy, may bring in the disease. In the first place, therefore, all intercourse with an infected or suspected focus must be prohibited, and prevented by sentries. Secondly, the successful measures of prevention embodied in General Baird's order to the army in 1801 should be instituted. They were as follow:— Importation.

1. To every hospital an observation tent was attached, and to it every case with febrile symptoms was sent, as soon as discovered, for observation. General Baird's order.

2. On any symptoms of plague appearing, the case was instantly sent to the infectious hospital (pest house), if there was any doubt about the case, the patient was placed in the observation

room of the hospital, and if the disease did not turn out to be plague, he was sent to the quarantine.

3. A minute medical inspection of every corps and department was made twice a week, and every person having the least appearance of ill-heath was sent to the hospital.

4. Every corps or hospital where the case of plague occurred was put into quarantine, and such corps or hospital was inspected at least three times a day, and every suspicious case sent at once to the observation room.

5. In suspected corps, bathing was enforced frequently, at stated periods, and the bedding and clothing frequently washed and baked. To all the hospitals ovens and smoking-rooms were attached.

Finally, quarters, hospitals, and camping grounds must be frequently changed.

The importance of strict quarantine was well shown in 1836 at Nussirabad. Here the British cantonment escaped infection by a rigorous quarantine, although thirty-two places in the neighbourhood were attacked.

Food.—The camp follower's ration should be an ample one. The ration generally here as elsewhere must be equal to the work to be done. Finally, abstinence is to be enjoined strictly. In the expedition of 1801 above alluded to, it is stated that "frequently the men were obliged to drink water," and "never indeed had an army before been so abstemious, and consequently so well conducted."

If imported. The measures to be followed, if imported, have been already indicated in General Baird's order. In addition, we would say that the rules laid down for typhus, as regards the sick, their attendants, hospital tents, bedding, excreta, are to be followed out here. The hospital attendants, moreover, must not mingle with their fellows, as it has been proved that healthy men can carry the infection without being themselves infected.

Nitrous acid. In 1801–2, nitrous fumigation was constantly practised. Lamps for this purpose were kept constantly burning in the observation tents, and in those from which the plague cases had come. When the stock of nitre was exhausted, marine salt was substituted for it. In a campaign, therefore, in suspected regions, arrangements for such fumigation should be made.

Conclusion. Sanitation, therefore, is our sheet-anchor in plague. In the pre-sanitary era, Napoleon lost 1689 men from plague in Egypt; such a result would be rightly considered criminal now.

CHAPTER X.

DENGUE.

It has been said that the first appearance of this disease occurred in India, in Rangoon, in 1824, when a body of our troops were suddenly seized with it. It has also been held that it is a disease peculiar to the tropics, and that it has not been seen in temperate regions. Medical officers were warned to expect it during the operations of war in Egypt in 1882.

Now, I believe that the above statements are not strictly accurate. As regards its first appearance in 1824, Hirsch shows it was known in India long before that date. But is it a disease peculiar to the tropics? I labour under the disadvantage of never having seen any cases of so-called "dengue" in India; nor have I as yet had any experience of relapsing fever in India. But during my student-days I saw relapsing fever. And from what I then saw, together with the clinical accounts of dengue as given by Hirsch and Bristowe, I would advance the hypothesis, that dengue is nothing more than relapsing fever. If so, the rules of prevention have been already laid down; but if not, the same rules will hold good, as dengue, as described by the above authors, is "contagious in a very high degree."

Supposing dengue to be for the moment a really specific disease, *per se*, it is evidently a disease which we should be likely to meet with in warm countries in any campaign. Thus, it occurred in Burmah in 1824; at Suez in 1824; in 1845 at Cairo; in 1851 at Réunion; in Zanzibar in 1870–71; at Aden in 1871; at Port Said in 1871; in 1872 at Rangoon, Burmah, Shanghai and Formosa, &c. Now at any of these places our troops may perchance meet with it; hence we must study its nature and prevention. I having no personal experience of so-called "dengue," must perforce draw my conclusions largely from standard authorities accepted as such by the profession, and I will therefore quote Dr. Bristowe and Prof. Hirsch somewhat freely as far as the clinical symptoms are concerned. For it will be necessary to enter briefly into the clinical aspect of dengue to support the view that we are here only dealing with relapsing fever; and having established this point, there will then be a "locus standi" for prevention. Geography.

Clinical Course of Relapsing Fever.—As a rule, we find relapsing fever commencing suddenly, with no premonitory symptoms. There is a rigor, followed by rise of temperature, and accompanied by headache and pains in the back and limbs. The

temperature rapidly reaches 104°–106°, and remains high, or higher, till the crisis. The pains in the back and limbs increase with the rise of temperature. With the advance of the fever, the pains in the muscles and joints, and the headache, become intense. Nausea and vomiting are common, sleeplessness invariably occurs, and is very distressing, whilst, as a rule, the mind is clear, and delirium rare and exceptional. The headache, joint and muscle pains continue to be intense throughout, and present a rheumatic character.

As regards the eruption, relapsing fever *is not characterized by any definite form.* It occurs more commonly in some localities than others. Obermeier, for instance, saw it in the majority of cases; Murchison in only 8 out of 600 instances. It occurs as a roseola, or mottling on the second or third day, or just before the crisis, and disappears after one or two days. There is sometimes extensive desquamation. The rash is just like that of typhus at an early stage. Next, we have one of the most characteristic symptoms—a profuse perspiration with a most disagreeable smell; this odour has been particularly commented on by several observers. This perspiration ushers in the crisis. The crisis consists in a sudden fall of the temperature, with departure of the distressing symptoms. It occurs on the third, or more often on the fifth and seventh days. We then have an intermission of two, three, five or twelve days—the average being 7.82 days (Murchison); after which there is a relapse characterized by the symptoms of the first paroxysm.

Amongst the symptoms, epistaxis may be noted as not at all uncommon.

As regards convalescence, this may be very slow; and is especially liable then to be attended with severe pains in the joints. Finally, pregnant women invariably abort.

Clinical Course of "Dengue."—Let us now summarize the descriptions given of dengue. The picture presented will be found to have a most extraordinary likeness to the above. Dengue, as a rule, commences quite suddenly with a rigor or chills, followed by a hot fit, in which "the temperature rises very considerably in a few hours not unfrequently reaching 103.5° and upwards." At the same time there occur extremely acute pains in the joints, headache, and gastric troubles. As the disease becomes more developed, the pains in the joints of the limbs and trunk increase, whilst that in the head becomes more intense. There is usually nausea, and often vomiting. There is great restlessness, and the patient is, as a rule, sleepless. Delirium is unusual. The pains in the back and joints, and the severe headache, continue till the remission. The arthritic pains shift about as in ordinary rheumatism.

On the third or fourth day, in about half the cases, a rash appears resembling that of scarlet fever, measles, or erythema. It is said to disappear on the second day, and to be followed by desquamation. With the subsidence of the rash, or about the

fifth, sixth, or seventh day, the fever and other symptoms abate, and the patient becomes free from his distressing symptoms. In a short time, however, a relapse almost as severe as the primary attack occurs; then another crisis, which may usher in a permanent convalescence; or may be followed by a second or a third relapse.

Amongst the symptoms epistaxis is common.

Convalescence is often very protracted, from pain and stiffness in the joints. Uterine miscarriage is very common, according to some observers. According to Bristowe abortion is, however, rare. Hirsch, in addition to the above description, describes *two* exanthems in the primary attack—viz., a more or less spotted erythema occurring on the third day, and lasting twenty-four to forty-eight hours, and then disappearing, accompanied by an outbreak of copious perspiration of a penetrating odour, with an abatement of the head and joint pains; then a remission; then, finally, a "second terminal exanthem" with febrile accompaniment lasting from a few hours to three days, and then disappearing. This second exanthem is said to take the form of bright red irregular spots, as in scarlet fever, measles, &c. Now we think that Hirsch here has only described one attack followed by a relapse.

Clinical resemblance of dengue and relapsing fever.

Now who can deny the extraordinary clinical resemblance of relapsing fever to the description of dengue as given by Bristowe and Hirsch. For, be it noted, the main points essential to the two diseases are identical—viz., sudden invasion, sudden and high rise of temperature, severe head and joint pains, distressing sleeplessness, rheumatic character of pains, epistaxis, rapid crisis, accompanied by mal-odorous penetrating perspiration, apyretic interval, relapse, followed by convalescence or further relapses. Again, in both, there may be complete restoration to health, or a long protracted sequela of arthritic affections. Again, in relapsing fever, women invariably abort; in dengue frequent abortion is recorded by certain observers. Finally, the rate of mortality in dengue and the ordinary form of relapsing fever is excessively small. As regards the rash, in neither is it essential; in relapsing fever there is no characterictic eruption (Murchison), it may be entirely absent, or it may occur in the majority of the cases; it also varies in its character when it does appear, sometimes being a roseola, sometimes like measles, but mostly like that of the early stage of typhus; in dengue it occurs "in about one-half the cases" (Hirsch), and is "not invariably present" (Bristowe). It takes on the form of a more or less uniform spotted erythema, or bright red irregular spots, as in scarlet fever, or measles, or urticaria. In both diseases it is followed by desquamation. Surely, if the "dengue" of the sub-tropics and tropics is not relapsing fever, it is the twin-brother to that disease.

Class of individuals attacked

Apart from epidemics of the disease which are stated to have attacked nearly every individual (*e.g.*, in Jamaica, Havana, Southern States of the Union), the classes attacked are first those

affected by relapsing fever. Again, in the case of epidemics, the disease is limited to towns for the most part. As Hirsch puts it, "the cramped and crowded life of urban populations, and the hygienic abuses inevitably associated therewith, present a peculiarly favourable soil for this to develop." And if we study the disease otherwise than in widespread epidemics, we find, for instance, that the cases in Java in 1872, in the garrison of Fort William I., were limited to the occupants of two block-houses occupying a peculiarly unhealthy site; those individuals, on the contrary, who were housed under more favourable conditions, enjoyed a striking exemption. Again, the Calcutta epidemic of 1871–2, occurred first amongst the Jews occupying the poorest and most densely populated parts of the city. Smart shows that crowded rooms and 'tween-decks of ships are the favourite seats of the disease. In the Philadelphia epidemic of 1870, dengue again was most prevalent in the filthy, overcrowded streets occupied by the poor. Finally, at St. Denis, in Réunion, the over-populated parts of the town were the chief seat of the disease.

Influence of season. The only particular in which dengue seems to differ from relapsing fever is in the matter of season. We have seen that the latter is uninfluenced by season, whilst Hirsch states that weather characterized by high temperature is an essential condition of dengue. Still there are exceptions noted—the disease occurring in damp and cool weather in 1827–8 in the West India Islands. Thus, it can occur in all seasons. But, inasmuch, as we hold dengue to be relapsing fever, it follows that no argument can be allowed as regards season, for cases like dengue clinically in every essential (viz., cases which make up the disease called relapsing fever) occur in every season.

Dr. Christie's theory. Dr. Christie holds a somewhat unique view—viz., that dengue is related to cholera, and is, in fact, "a distinct variety of cholera," in which "the infective virus of cholera is so modified by products of human decomposition as to give rise to dengue." It is somewhat difficult to grasp the meaning of this sentence. Nevertheless, though given to this theory, Dr. Christie is practical as regards its prevention. He insists on the most improved sanitation and a more careful disposal of the dead.

Preventive treatment. Although both Hirsch and Bristowe describe the disease as different and distinct, and suggest no affinity or identity, yet the preventive measures indicated for relapsing fever are equally indicated here. Overcrowding and poverty are both etiological influential elements in dengue and relapsing fever; both occur in overcrowded conditions of land habitations and ships. Hence, the disease is essentially one that will be imported by coolies and camp followers. Dengue is extremely contagious. Let, therefore, the measures previously indicated for relapsing fever be applied here, not forgetting Dr. Christie's admonition about the careful disposal of the dead. The dead, however, are not, at any rate, a fruitful source of infection, as the mortality has been shown to be small. These measures include thorough disinfection of everything in connection with the patient. The disinfection must

be thorough, for the contagion is long-lived. Thus, Horton relates that the disease was transported from the West Indies to the west coast of Africa in the dirty linen of the female followers of soldiers, during the relief of the detachments of the West India Regiments.

Prophylactic "ration."

In the great epidemic that occurred at Charleston in the autumn of 1879, a quinine ration was given as a prophylactic. It had, however, no specific influence. It has been shown that in relapsing fever quinine has been tried with a like result.

CHAPTER XI.

SIMPLE AND ARDENT CONTINUED FEVER.

As before observed, in our remarks on malarial fever and enteric fever, it has not been as yet determined to what extent all these different febrile diseases mutually occur. Up to, and including, 1882, there were only two campaigns in which simple continued fever has been especially segregated in the classification of invaliding—viz., in Malay, and in the Indian Expeditionary Force to Egypt in 1882. Dr. Colvin Smith in his return divided his cases of fever in Egypt into—1, ague; 2, febricula; 3, sunstroke; 4, enteric. There is here something tangible and definite, and as such I produce it here for an example:—

Indian Expeditionary Force for Operations of War in Egypt in 1882.

Strength	5674	
Admissions	846	
,, per 1000 . . .	149.10	
,, for ague	123,	or 21.67 per 1000
,, ,, febricula . . .	28	
,, ,, sunstroke . . .	14	
,, ,, enteric fever . .	1	

We have only given the admissions bearing on this portion of our subject. In all the other campaigns, except that in Malay, such a heading as "Simple Continued Fever" is conspicuous by its absence. As we have shown before, it is of importance to the pocket of the State—and this is always an argument *ad rem*—that fevers should be discriminated. I have found that the largest proportion of cases of fever in India have no malarial element in them whatever; the patients get rid of their fever either with a placebo or a diaphoretic, whilst their charts exhibit only simple continued fever. This would seem also to be the case in war; for since 1882 the fevers in our campaigns have been more carefully returned. Thus, amongst the non-commissioned officers and men of the regular forces employed in the Nile expedition 1884–5, the ratio of admissions for malarial fevers and simple continued was as follows:—paroxysmal fevers 5.7 per 1000, simple continued fevers 94.79 per 1000, febricula 57 per 1000; whilst amongst the Canadian voyageurs and other Irregulars there were 58 admissions for simple continued fever and febricula, and only 4 admissions for paroxysmal fever.

Nature of Class of Simple Continued Fever.—Under the classification of simple continued fevers we include all those febrile attacks independent of any specific poison, non-contagious,

and brought on by want of caution, or impossibility of precaution, from the effects of the sun, fatigue, excesses, &c. They have a wide range of severity, from the mild ephemera to the so-called severe "Ardent Continued Fever of the Tropics." The latter class again merge into certain forms of sunstroke. I, however, exclude sunstroke from this chapter, as its pathology is not so simple as that of ardent continued fever, and also because blood-letting is indicated in certain cases of the latter, but never in sunstroke. But as regards the external factors of causation, many will be found to run in the same groove. Thus, direct exposure to the sun will cause both ardent fever and sunstroke. Let us now consider the "natural history" of the class of cases included under simple continued fever.

As regards age, our men are just about the age most liable to be affected. Murchison found, as the result of 845 cases admitted into the London Fever Hospital during ten years (1848–57), that the mean age was 22.82. Again, his experience in Burmah and India led him to the general conclusion which coincides with all experience, that "it is the young and robust persons newly arrived from temperate climates who are most liable to suffer from ardent fever." Hence, we see the subject as regards age alone demands especial attention. Age.

As regards season, cases are most likely to occur, especially in the more severe forms, during the hot months. In India, Murchison has, during the hot season, seen what he describes as an epidemic form. I have not seen this degree, but, according to my experience, the hot season certainly is the season when the severest forms come in. Here, therefore, season is in our favour, for our campaigns are always when possible, carried out during the cold weather in warm climates. Season.

We have defined the causes and etiology of *ephemera*, *sun fever*, *ardent continued fever*, and *synocha*—all these being related fraternally—as chiefly springing from exposure to the sun, fatigue, excesses, &c. I now proceed to briefly indicate how these forms of fever may be avoided.

Clothing.—The best material for dress has been already indicated. Chill is a fertile source of ephemera, and the remarks concerning the materials best suited for preventing chills need not be repeated here. The form of head-dress most suitable for combating the effects of direct exposure to the sun will be considered in detail under sunstroke. Finally, I would repeat here, that, after exertion, the men should change their shirts and socks as soon as possible, or, if not, put on their great coats, so as to arrest any chance of chill and consequent fever.

Marching.—The remarks made in the chapter on Malaria, need not be repeated here. We have seen that the great indication in marching is to avoid as much as possible the sun.

Food.—All excesses tend to induce simple fever. In the actual field there will be no opportunity for excess; but on the capture of the enemy's strong places, or in camping near towns, the men must be prevented from breaking into the liquor-shops.

Fatigue.

And as regards the elements of fatigue, the food again must be sufficient for the work done, and the bodily strength must be husbanded consistently with the military situation.

Camp.—In camp, the men must avoid all needless exposure to the sun. They should remain in their tents, which must be ventilated as much as possible, till the great heat of the day is over. Other points as regards their tents will be mentioned under Sunstroke. But it must ever be borne in mind that exposure to the sun is one of the chief causes of inefficiency.

Seasoning.

Seasoning.—The element of seasoning enters in here. It is almost needless to state that the unseasoned are most liable to be affected. Hence, where possible, selection of the "seasoned soldier" is indicated as regards continued fever as elsewhere. Dr. Bryden, in his "Vital Statistics," shows how "heat fevers" especially affect men in their first year of service in India. The ratio of mortality per 1000 for "heat fever" in the newly arrived army in 1858 was 21.93, whilst for the same body of men in 1859 it had sunk to 6.58. Hence, men on first arriving in India should for this reason again not be sent on service.

Example.

The following account of ardent continued fever, as regards etiology, illustrating many of the preceeding points, will fittingly conclude this section. Murchison states that the disease, as he saw it among the European troops in Calcutta and Burmah, chiefly attacked the young plethoric recruits recently arrived from Europe. It prevailed mostly in the hot dry months, and in many cases the symptoms commenced immediately after incautious exposure to the direct rays of the sun.

Much of the preventive treatment indicated in the next chapter is applicable to these forms of fever.

CHAPTER XII.

SUNSTROKE.

The prevention of sunstroke is one of the most important in the whole range of military medicine, not only on account of the direct mortality of the disease, but also by reason of those sequelæ which will indeed incapacitate a man from further military service in warm countries.

Sunstroke is in a great measure an eminently preventable disease. Dr. De Renzy, in an excellent paper on "The Prevention of Sunstroke in our late War in the Soudan," has especially urged that, with due provision, sunstroke may, in a great measure, be obviated. This distinguished officer—who has done so much in the extinguishing of epidemics of cholera by working on rational lines—has shown how Mooltan, with a climate several degrees hotter than that of the Soudan, can yet show a very fair standard of health as regards the troops there quartered. And assuredly heat can hardly exceed that of Mooltan, where in June the temperature in the shade registers 120° F., and a black bulb thermometer, 176°.

Let us, therefore, briefly consider the factors entering into the etiology and pathology of sunstroke. We know of no such clear description of sunstroke as is to be found in Morache, and we accordingly refer to it, in order to gain a clear basis for prevention. Morache clearly differentiates the two great subdivisions: "tres tranchées au point de vue de l'etiologie, comme à celui des symptomes et de la pathogenie." We have first the cases due to "Coup de soleil" proper, in which, following direct exposure to the rays of the sun, we have a "classical" cerebral hyperæmia, accompanied, it may be, by hæmorrhage, and followed by apoplectic coma. As Dr. Bristowe puts it, the symptoms differ little, if at all, from those of the typical apoplectic state.

A. Coup de soleil.

The second class of cases, containing the greater number, is that caused not by the direct rays of the sun, but by the heat itself of the atmosphere. This heat causes an initial excitation of the muscular elements of the superficial arterial circulation; the vessels contract, and the action of the skin ceases. The cerebral circulation is also affected, and we have, following, a cerebral ischæmia with acceleration of the cardiac and respiratory movements. This stage of excitation is followed by depression of the muscular contraction; the circulation slows; the viscera becoming congested, till at length the heart's action becomes inert, ceases, and death supervenes.

B. Coup de chaleur.

This description of the pathology of the processes in the two classes is, in the main, confirmed by Roth and Lex, who state that in the class of cases included under sunstroke, death in the majority of cases occurs from cardiac paralysis, and only occasionally from cerebral disturbance.

Now all cases of sunstroke will come under one or other of these subdivisions of its pathology. Our soldiers are either struck down on the line of march, or in their tents. And the experience of all teaches that the latter mode is the most frequent. Surgeon-Major Horton demonstrates this for West Africa. It occurs in our troopers on their voyage out to India; indeed, the first case of "heat-stroke" that I came across was that of a soldier who was seized in his bunk in the Red Sea on the voyage to India. In the China war Dr. Rennie found that most cases of "sunstroke" occurred in men who had not been exposed to the sun for several hours previous to the attack. Hence, we arrive at one fact in the history of heat-stroke—a preferable term generally than sunstroke—that the great majority of cases occur from a highly heated atmosphere, and not from direct sun action. But direct insolation will occur much more frequently where it is, as it were, aided by a greatly heated atmosphere, especially when that atmosphere is also humid, for in this combination of both causes acting together excessively, the natural protection afforded by evaporation from the surface ceases, and thus the retention of heat in the body is not alleviated. Obermeier's experiments on dogs show how, in a temperature of 30° to 35° C., the body temperature mounts up to 46° C., and death supervenes. And in addition to this, Wallther's experiments show that the heat from the streaming rays of the sun can be actually absorbed by the skin. Finally, Thiersch has shown that an actual disintegration *en masse* occurs in the red blood-corpuscles, thus still further aiding both the apoplectic condition, and the state produced by cardiac failure.

Summary. To sum up the etiology, we would substitute for the generic term "sunstroke," that of "heat-stroke." The two great classes of heat-stroke then are—1st, direct solar heat-stroke; and 2nd, indirect solar heat-stroke; these correspond respectively to the "coup de soleil" and the "coup de chaleur" of Morache. In direct heat-stroke, the primary effect is on the brain, inducing cerebral hyperæmia. This state, moreover, is aggravated by the increased heat produced by the muscular exertion of the march, and, moreover, may be still further aggravated by a humid heated atmosphere. In indirect heat-stroke, we have a primary effect on the skin and brain vessels of excitation; to this succeeds increased action of the heart; the stage of excitation is followed by that of depression, and cardiac paralysis supervenes. This condition, in its turn, is aggravated by stagnation and impurity of the air, especially in the field, where the conditions of camp are wont to aid the effects of indirect heat.

What, then, from this review, would appear to be the two great preventive remedial measures? To this we reply for the first form—the "coup de soleil"—a proper protection from its assault

on the head, eyes, and body. For the second form a proper ventilation. And, inasmuch as the latter form—the "coup de chaleur"—is by far the most frequent; inasmuch, moreover, as the very bearers of oxygen—the red corpuscles—are themselves disintegrated, we see that it is in better means of ventilation, including, under this, renewal and cooling of the air, that the mortality and invaliding of "sunstroke" in the field will be lessened. And finally, as we shall see, even the "coup de chaleur" plays often a helping hand to the "coup de soleil." I will now proceed to indicate the main points for the prevention of heat-stroke.

The points regarding seasonal and meteorological changes that are to be borne in mind are chiefly the following: The hot season should, of course, be avoided if possible. The Hazara campaign in 1868 gave a striking example of the danger of marching in the hot season. The 38th Regiment left Sealkote to march to the rendezvous at the Black Mountain. Marching during August, this regiment had the largest number of cases of sunstroke for the year in India—viz., 51. During 1868, again, there were 241 admissions for this disease. Of this number, 144 occurred in troops marching to Hazara, whilst of the total number all but 14 occurred from June to September. The maximum number in any month—114—occurred in August. Again, in the Afghan war in 1879, there were 36 admissions. Of these, 28 occurred in June, and 32 from June to August. In 1880 there were 46 admissions; of these 36 occurred from June to August. Again, in the second Burmese war, 1852, the troops were landed in April at Rangoon. The deaths from sunstroke are reported to have equalled that from the fire of the enemy. Warm days in the cool seasons of the year are especially dangerous (Roth and Lex). Moist air, absence of wind, and hot winds, all favour the development of the attacks. In his account of the diseases prevalent in the Persian Gulf, Evatt draws attention to the terrific heat, of a moist character, there prevalent. Even the natives of the country cannot endure it, and heat apoplexy assumes a deadly form. This fatal character of the heat is derived from its moisture. On board H.M. ship *Liverpool* three officers and twenty-one men were seized on one day. Again, further inland, the intense heat again assumes a terrible aspect from the hot winds drying the skin and abolishing the salutary effects of perspiration. When, therefore, the above conditions are present, especially must the medical officer be on the look-out for the premonitory symptoms of sunstroke, and take measures against it.

Season and meteorology.

Hazara, 1868.

Afghanistan, 1878-80.

Second Burmese war, 1852.

As regards the geographical distribution of the disease, Dr. Paynter has stated that sunstroke is never met with in the French army in Algiers. Hence it might be supposed that in the sub-tropical climate of North Africa we might be free from it. Our experience in Egypt shows this, however, to be erroneous; and, moreover, in Algiers itself sunstroke does occur. Laveran, for instance, relates that in an expedition in 1836, under Mar-

Geography.

shal Bugeaud, 200 men were seized with heat-stroke, of whom eleven died.

1. Previous sunstroke.

Selection of Men.—A man who has once had a severe heat-stroke should never be allowed to go on a fresh campaign in a tropical or semi-tropical climate, for, if so, he will become affected probably again by a much lower temperature than he otherwise would be. Again, new arrivals suffer more than seasoned soldiers. Bryden, in his "Vital Statistics," shows the effect of the sun on new arrivals in India. The liability of newly arrived troops in India is quadrupled. Taking the standard of ten years 1860–69, the admission-rate for heat apoplexy was 4.3 per 1000, whilst that of newly arrived regiments for the years 1864–9 was 16.8 per 1000. Still more does the rate rise if a newly arrived regiment in India is sent into the field at once. Thus, the ratio for the new army in the field in 1858 was 55.8 per 1000. The diminution of heat apoplexy with length of service in India is shown in the case of the newly arrived army in 1858. Here, in 1858, 42.9 per 1000 were admitted; in 1859, 8.7 per 1000; in 1860, 6.2 per 1000; in 1861, 2.2 per 1000; in 1862, 1.19 per 1000; in 1863, 1.09 per 1000. Sir Ranald Martin relates an instance of the effect of seasoning. During a march in May of forty miles under a powerful sun, the heat was nearly beyond endurance, yet not one European officer, commissioned or non-commissioned, was affected. All were young, healthy, and well seasoned to the climate. Plethoric, intemperate, and men suffering from fatty heart, are especially predisposed. Lastly, Hutchinson has found that syphilis has, in a large majority of cases, antedated the attack of sunstroke. During peace time our men should always be well practised in route marching, for if well seasoned thus, the danger of *sudden* rise of temperature from severe exertion should be guarded against. And for any given small select foray, it will be well to select chiefly cavalry, should military reasons allow of such choice, for reasons to be presently stated.

2. New arrivals.

3. Plethora, intemperance, fatty heart.

4. Syphilis.

5. In small forays.

(*a*) Period.

Marching.—It is needless to state marching should never be done in the middle of the day. In the passage of the sun's rays through the atmosphere the loss of the heat which they contain by absorption is more than 20 per cent. on a vertical, and almost all on a nearly horizontal, beam. The sun is therefore hotter at noon than in the morning or evening. The men must march either in early morning, in the evening, or at night. As regards night marches, the French in Algiers did not find them advantageous; they seemed to tax the strength of the troops too much, and the men came into hospital. This was not entirely our experience, however, during the Afghan war. The men were marched at night through the Bolan Pass on the Candahar line, thus escaping the excessive heat of the day. Moreover, the element of "fatigue" was provided against, for our men were provided as much as possible with cart carriage. By marching thus at night the heat of the sun is entirely avoided.

Still, except in very great heat, I would advocate either marching in the very early morn, or else executing the march in halves,

one-half in the morning, and one-half in the evening. As a rule, there is no doubt that night marches, if continued, are excessively fatiguing. No sleep by day compensates for the want of sleep by night.

(b) Food. Before the commencement of the march, the men should have a light breakfast of biscuit, or bread, with tea or coffee. They should never set out on an empty stomach, otherwise the element of fatigue will soon set in, owing to there not being sufficient fuel for the machine. Exhaustion so induced tends of itself to lead to suppression of the functions of the skin.

Bheesties. Plenty of bheesties should be at hand with water, so that the men can drink whenever they require. They should, however, be cautioned not to take too large quantities at a time. No harm can ensue from drinking small quantities of fluid when heated or exhausted, but should an excessive quantity be taken a dangerous shock may be administered to the nerves of the stomach from this very excess.

Water bottles. Provision should be made allowing the men to fill their water-bottles with vinegar and water, or coffee, or tea, especially the two latter. Their action as regards heat-stroke will be further adverted to.

End of march. At the end of the march, should the heat be very exhausting, let some warm chocolate or coffee be served out, as at Assayboo in Ashanti. This will greatly refresh and cool the men, as was found in the Burmese war after the most severe marching.

(c) Open order. Free open order of march is of supreme importance. As much intervening space between the files as is possible must be given. Never march in close order. By allowing free open order, we bring in the aid of free ventilation, and so increase the power of evaporation from the skin, and thus diminish the internal heat of the body; whilst by marching in close order the surrounding atmosphere soon becomes moist from the perspiration. Thus during the march for the relief of Abracampa in the Ashanti war, the heat being stifling, and there being very little breeze, or none at all where the road was shut in by the bush, the men soon began to fall out, and many became convulsed and insensible. The column was then ordered to march in the loosest order possible, with at least 6 feet between the files, and the pace not to be more than $2\frac{1}{2}$ miles per hour. All experience shows that crowding, whether on the line of march or in tents, is most dangerous when the sun is hot. The air becomes impure, the action of the skin is checked, and thus the effect of heat is powerfully aided. During a certain march in India, Dr. Taylor detected the early signs of heat-stroke supervening. He immediately obtained an open order. The symptoms disappeared from amongst the men, and only one man became affected. The good effect of open order is seen especially in the cavalry. Here sunstroke is far less frequent than in the infantry on the line of march; but the men are separated by greater intervals, and, moreover, breathing higher strata of air, there is less dust, and thus again a more ventilated air is inhaled.

(*d*) Dress.

Again, let the men open their coats and shirts; let no constriction play upon the neck or chest. In the Zulu war all the men were ordered thus to open their coats and shirts directly the heat became oppressive. Let the impedimenta be carried for the men also as far as possible: everything that lessens the work done, and therefore is preventive of fatigue, lessens the liability to heat-stroke. Especially must all constricting impedimenta be removed. The old knapsack must have powerfully aided the effects of heat. The injurious effect of tight constriction round the neck was shown in the assault on the White House Picquet in the Burmese war, where numbers of men were attacked by the sun, and fell down unconscious. These men wore the tight oppressive stock of that period. Again, during the Chinese war, on the march from Chin-kiang-foo, the 98th Regiment, just landed, were ordered to mount an ascent; the heat was intense, and a number of the men were mortally struck down by it; their uniforms were worn buttoned up. During the same operations, the 18th, 49th, and 55th Regiments did not lose a single man, although they were equally exposed; they wore their uniform open, and their necks were free. Other remarks on dress will be considered later.

(*e*) Halts.

Let there be regular and sufficient halts. It has been found that a quick march of the duration of one hour and a half will raise the temperature 1.2° C.; but not only will the action of the march, *per se*, in elevating the temperature thus become apparent, but it will be aided by the element of fatigue should there not be a sufficiency of halts. At the halts let the men drink their coffee and tea, or, in default, let them have water supplied by the bheesties. Let, if possible, a shady place be chosen for the halt, or, if not, an open field where free ventilation can come into play. Do not halt on a hot, stony and sandy locality if possible. Thurn found the temperature of a man sitting in the sun rose nearly two degrees in a given case. Again, M. Guyon has drawn attention to the danger of lying down during halting. He points out how excessively heated the layers of the atmosphere nearest the ground are, and says that heat-stroke is particularly apt to occur, and indeed most often occurs, during halting. Marshal Bugeaud issued an order in July 1846 proscribing men from lying down during halts on the line of march for this reason.

Danger of lying down.

(*f*) Alcohol on the march.

We have reserved a separate place for alcohol as regards marches in hot climates. Alcohol should never be allowed *on* the march. The question of giving alcohol after certain conditions of the march has already been referred to; what is to be insisted on is, that it must never be given during the march in hot climates. Dr. Fergusson relates an instance of the bad effects of such distribution. At St. Domingo, the 67th Regiment, in the expedition of 1796, was on the line of march in a dry, rocky country, in which no water could be found. The men, however, were freely supplied with rum, they soon began to fall out at every step, nineteen died *en route*, and the remainder completed the march "in an indescribable condition of exhaustion."

We have already insisted on the danger of excessive fatigue in marching in a hot country. To obviate this, in addition to the foregoing rules, the pace of the march is to be carefully regulated. A single regiment on the line of march can do $3\frac{1}{2}$ miles per hour without bad effect. The case, however, is different when several regiments, or a brigade, are moving together; here $2\frac{1}{2}$ miles or 2 miles should not be exceeded, for it must be remembered that the regiments in the rear will be breathing an atmosphere filled with dust. In the tropics, in a given cubic space there is less oxygen than in temperate climates. At 80° F. a man receives 9 per cent. less oxygen than at 32°; the respiratory acts again are diminished, hence the danger of great exertion, which will be still further aggravated by the dust-laden air. It is here, indeed, that the effects of the "coup de chaleur" will be superadded to those of the "coup de soleil," for we have shown how, in the former, paralysis of the heart is apt to come on; this palsy will, of a surety, be powerfully aided by the greater resistance in the aorta from severe excessive muscular exertion in marching, combined with mechanical hindrance to the circulation of the lungs induced by the dust-laden air. (*g*) Fatigue.

Finally, a day's rest at settled regular intervals must be ordered.

We now see why cavalry are less liable than infantry to heat-stroke on the line of march. Being mounted, the element of fatigue is reduced to a minimum, each file has good cubic space. Each man also is further away from the heated lower strata of the air, and is less choked with dust, whilst, as we shall see, the Indian cavalry at least have a better head-gear.

In concluding our remarks on marching, the medical officer should be on the look-out for the early signs of sunstroke, such as stumbling, uncertain gait, cessation of perspiration, &c. Should these come on, the foregoing measures must be especially insisted on. The rules laid down in the chapter on Marching, Part I., should also be consulted. (*h*) Diagnosis.

Uniform.—As regards the direct effect of the solar rays, the most important fact in prevention is the constitution of the head-gear. In the first place the head must never be exposed uncovered to the sun. This may seem a common-sense axiom which hardly needs stating, but such common-sense axioms have to be driven into the British soldier. Hence, the men must be warned fully on this point.

As regards the men, we believe the bamboo wicker helmet to be an inadequate protection, whilst, as regards officers, the regulation white cork helmet, from its shape and make, is in very hot weather simply a sun trap. The usual shape is erroneous, leaving the temples too much exposed. The pressure, again, of the cork helmet, with its puggery, its a prolific cause of headache. Would any sportsman in the jungle use a military helmet?

The first year of the Afghan war I had campaigned as medical officer to a mountain battery. Here the grey felt helmet of Elwood, with double (air chamber) lining, was the uniform head-dress. Of this helmet more anon. Suffice it to say that no dis-

comfort was ever felt from it, notwithstanding that I had gone on service straight on arrival in India, and so was quite unacclimatized. Surgeon-General Moore, of the Bombay Service, holds that Elwood's felt helmet is the best yet supplied. Having been invalided at Cabul, I had to take sick leave to Australia. On return I was sent on the Candahar line, and on this occasion had to wear the infantry helmet. On the second day's march from Quetta I was seized with nausea and fainting from the intense heat; a bheestie was near, and the symptoms passed off after repeated douching. Four days after I had another attack, ten days after which a third attack came on, both on the line of march; four days after this seizure I accompanied my regiment on an expedition against some marauding tribes, and was this time seized with sunstroke. Two months and a half elapsed before I had recovered sufficiently to leave India for two years' sick leave. On return to duty, within three months fresh symptoms set in from the sun, necessitating another period of six months' leave to the hills. I lay the whole etiology of the above to the regulation military helmet at present worn in India. This helmet has not many elements in its favour, it is heavy and hot, and does not protect the temples.

The question of "helmeting" our troops has been considered by many writers: all have, however, tried to preserve the present shape more or less. We believe that the best helmet for campaigning is that worn by the Shikari: it is light, has a free circulation of air around the head, and protects the eyes, temples, and nape of the neck. It has been said that this solah topi is apt to get out of shape, to fall to pieces, and to predispose to sunstroke—but is this the case? A good thick topi will last for years without breaking or getting out of shape. And, as regards the statement that they are less protective against sunstroke than "wicker" helmets, I believe this to be entirely erroneous. The sportsman has not learnt by experience to prefer a topi which causes sunstroke. We are glad to see that a step has been taken in this direction, for in the reports of the Soudan expedition, the engineers are stated to have worn solah topis. This, then, is the head-covering to be recommended for campaigns in tropical climates. The topi could be fashioned so as to retain a smart appearance, whilst giving protection to the temples and nape of neck.

Colonel Massey, of the 95th Regiment, in the A.M.D. Reports for 1869, would recommend a hat of a stout grey felt, with a broad rim, somewhat of the shape of one of Elwood's broad brimmed grey felt topis, with a tolerably high crown, and an air chamber. This helmet does not, however, give sufficient protection for the neck, it must therefore be supplemented with pieces of cloth flowing from the helmet down over the neck. Two such flaps depending well over the neck, will not only keep off the sun's rays, but, by flapping in the wind, will cause movement of the air around the neck, and thus aid evaporation, and cool the parts. The broad brim on its under-surface must be covered

with green cloth. The crown of the hat should have the bulging air chamber of Elwood, over which a puggri is to be folded, whilst, finally, a white drill cover should be fitted on. Roth, vol. iii. p. 75, quotes Conlies, and shows that the addition of a white cover to the helmet lowers the temperature inside as much as 7° C. With such modifications, we think Col. Massey's helmet would also afford an excellent protection from the sun.

Should the present wicker and cork helmets be persisted in for the men, their shape should, at any rate, be altered in one important particular. This point has been especially insisted on by Major Blakeney, of the Highland Light Infantry. He points out that the regulation service helmet has a pointed peak in front, which prevents the helmet being brought down low enough to cover over the side of the head. This pointed peak it is necessary to abolish, so that the side of the helmet can come down over the temples. The temples are the parts requiring especial attention in the early marches in the tropics, when the sun is low and not directly over the head. The helmet is made grey, as being both cool to the head and invisible to the enemy, and the puggri is made in strips or flaps where it hangs down over the neck, thus permitting of a constant moving current of air.

As regards the cavalry, we think that nothing can be better than the lungi. There has been a discussion lately concerning cavalry uniform, and all writers seem pretty well agreed that a good thick lungi is the best protection from the sun.

There is, finally, one part to be protected especially. Strange **Spectacles.** to say, I have not found any mention of this important means of prevention in any work relating to sunstroke. I allude to neutral-tinted spectacles. Now, if spectacles can be worn for prevention of ophthalmia as they were in Egypt, they can be equally worn for sunstroke. They could be removed on coming into touch with the enemy. My opinion is that the effect of the sun is more frequently caused through the channel of the orbit, than through the temples or vertex. It stands to reason that there must be far less resistance to the passage of the rays reflected from the ground, the parts are soft, not bony. And again, apart from the mechanical aspect, we have the optic and other nerves and vessels here directly almost exposed to the heat rays. The relief to the eye and sense of coolness imparted generally by neutral-tinted glasses must be felt to be appreciated.

Before concluding this important part of our subject, it may be mentioned that many officers in Egypt wore a head gear similar to those worn by the officers of the mail steamers of the Red Sea and Indian Ocean, and these hats were considered a great improvement on the regulation military helmet. The correspondent for the *British Medical Journal*, also gives us another hint; he states that old European residents in Egypt, whenever going into the desert shooting, or on any employment which exposes them to the sun, wear under their hats the tight jean skull caps which the Arabs wear under the turban or tarboosh,

and find that it greatly diminishes the penetration of the heat rays. Some of our officers in South Egypt adopted the white cap, wearing it under the military helmet, and found it to answer admirably. Surgeon-General Moore advises, indeed, that there should not be too great a ventilating space between the head and helmet, for if so, hot winds penetrating freely over the scalp, the skin is maintained constantly dry, and thus actually predisposition to sunstroke effected. Only a small quantity of air should pass, he says, between the outer and inner layers of a good topee, and no air between the head and inner layer. To sum up, then, we would provide every man, mounted or otherwise, a pair of neutral-tinted spectacles, and the above white cap, to be worn under a solah topi or lungi; should the solah topi not be allowed, then a felt helmet, with air chamber of the shape indicated. But for the men we hold a solah helmet indispensable.

Protection of spine.

The next most important region to protect is the spine. The spinal cord, according to Moore, is always largely implicated. A thick woollen spinal pad must be worn, sewn into or on the coat. Moore, however, advises in preference that the ends of the puggaree be prolonged over the back, and attached to the waist. An ingenious but cumbersome contrivance is advocated by Jeffreys—namely, a curtain of white jean suspended from the shoulders, and propped out from the back with little bows of steel, so as to permit of the circulation of air.

Dress for body.

We have already fully considered the make and material of the dress for tropical campaigns. We need only repeat that a looser woollen Norfolk jacket is indicated. It must be especially loose round the neck, chest, and abdomen, for tightness round these parts disposes to heat-stroke. As regards colour, the experiments conducted some time ago at Aldershot, showed that the least absorbing colours for the direct heat of the sun were white, then grey, yellow, pink, and black. It has been found that white reduces the temperature 2° in the shade, and a temperature of 130° to 110° in the sun. A light grey kharki serge is indicated as being most serviceable. As we have pointed out, a cotton dress is never to be worn; as regards sunstroke, this is especially important, for the sun's rays falling on the clothing warm it, and the air contained in it, and so diminish the giving off of heat from the body. Now cotton is, above all, a great conductor of heat, whilst wool, on the other hand, is noted for its slow conducting power.

I have already shown, under the conditions of marching, how important it is that the dress should be free and loose. The point ever to be borne in mind, and one that cannot be too frequently repeated, is, that "the clothes be loose and light, so as not to interfere with the free movements of the chest and evaporation of the skin, and so as not to obstruct the cervical circulation." Dr. De Renzy, who has thus insisted on loose clothing, illustrates this by a case under his own observation. At the capture of Rangoon, in 1852, "of two sets of men who were alike in all other respects, one fought in shirt sleeves under an intensely hot sun, the other

in blue cloth tightly fitting coats, many of the latter began to drop down insensible shortly after coming into action, their commanding officer being among the number." The main thing in conclusion is to assimilate the war kit to the sporting kit. It is well known that sportsmen can be exposed all day to the hottest sun in Central India, without outward results.

The Camp.—Military reasons, as already remarked, will often not allow us to pick and choose ; again, the nature of the country campaigned in may leave us no choice ; we can, therefore, as regards site, only indicate what is unfavourable, or the reverse. The hottest ground to encamp on is sandy ground. The heat is often so intense that even the natives forsake such plains in the hot weather. This was the case at Sibi and the Lower Bolan, where, during the hot months, the natives are accustomed to move higher up. Here the greatest heat was experienced during the Afghan war. Sir John Herschel found a superficial temperature of 159° in dry sandy soil at the Cape. Site.

Schubler, quoted by Morache, shows the relative power of absorption of heat of different soils, that of sandy being 100, as follows :—

Power of retaining Heat—100.

Sable calcaire	100.0	Calcaire	61.8
Gypse	73.2	Humus	49.0
Argile	66.7		

Grassy uplands, as on the top of the Peiwar Pass, affords splendid camping grounds, especially when they are, as at the latter, covered with pine woods. Hence, take advantage of such uplands, and move as many companies of the regiments as consistent with military precautions, to any hill plateaus bounding the road of advance. In this way, during the summer of 1879, batteries and regiments were moved away from the Kurram plain to the upland stretches of the Safed Koh range. My regiment, the 23rd Pioneers, was thus divided: head-quarters moved up a gorge to within one mile of the snows, high up in the mountain range, whilst the remaining wing was left seven miles below in the sweltering plain. In journeying from one camp to the other the traveller left a temperate for a tropical heat.

But more often Nature can afford us no aid. We must then have the most open order of camp possible so as to avoid all stagnation of air. For it is in camp that most cases of heat-stroke will occur. Men are far more frequently seized when lying down in close stuffy tents than in the open. At the base, where our men may be perhaps lodged in buildings, punkhas can be extemporized. But in tents we cannot do this ; we can in some localities build a wooden erection over the tents where wood is plentiful. This was done on the plateaus of Ali Kheyl in the summer of 1879. The 92nd Highlanders and Swinley's Battery sent out fatigue parties for boughs and foliage, and the tents were gradually roofed over, thereby reducing immensely the temperature. Morache also proposes douching the sites of the tents exposed to the sun. But where is the water to come from ? In most camps Open order. Roof tents.

water and labour would be wanting sufficient for this purpose. Moreover, under the constant drying and wetting, the tents would rot. Again, when feasible, floor the tent with small, leafy branches. Nothing can be healthier than such a floor of pine foliage, where, independently of the protection from the heat radiated from the ground, we shall enjoy the healthy resinous exhalation. By such means were the heat rays deprived of their strength in the Upper Kurram.

Floor the tents with green.

Double fly.

The tents should have a double fly. A single fly tent is powerless. An ingenious contrivance was invented and carried into effect by an officer, who had his outer fly made in the form of a sack. Arrived in camp, he set his servants to collect foliage, grass, &c., when possible, and thus filled the sack of his outer fly, rendering it still further protective. As regards the colour of the tent material externally, we have seen that a pale yellow is the best as regards absorption of heat; but we would deprecate the bright yellow lining made for Indian tents. The glare is tremendous. A light blue colour is far superior. Morache recommends, in addition, lining the tent with a woollen material, thus taking advantage of the bad conducting power of wool for heat.

Avoid overcrowding.

Never overcrowd the tents; if so, the organic matters exhaled become concentrated, and thus greater decomposition of them by the heat occurs; the air thus rendered impure is re-breathed, and thus a vicious circle established. The number of troops to be placed in a given area must be determined by local circumstances. In the "Memorandum of Field Service Arrangements for the Guidance of Medical Officers employed on Active Service on the North-West Frontier," issued by the Surgeon-General's Office, H.M. Forces in India, in view of eventualities with Russia, a useful estimate was given in this respect, showing the extreme limits from great overcrowding to what would be an impracticable though desirable amount of space; it is as follows:—

Square Yards per Tent.	Tents per Acre.	Troops per Acre at 12 Men per Tent.
50	96.80	1161.8
100	48.40	580.8
400	12.10	145.2
1000	4.84	58.0

If sufficient ventilation cannot be carried out by raising the kanats of the tent, then raise the whole of the side away from the sun; by this means there will be, at any rate, ready escape for the products excreted from the lungs, and removal of air.

At night, where no malaria exists, let the men sleep outside their tents rather than in them. But where the seat of campaign is in a dense, hot, malarious country, the problem for providing against malaria and heat-stroke simultaneously will be one sufficient to tax the forethought of the most experienced. In concluding our notice of the camp, we would reiterate the

warning against overcrowding in relation to sunstroke, in the words of Dr. De Renzy: "Crowding, even though it is only for a short period, is most dangerous when the sun is very hot."

Food.—We now have to consider the question of food as regards heat-stroke. We must first insist, as we have done so often, that the ration must be in proportion to the work done. This has already been fully entered into. Again, where heat-stroke is apprehended, beware of too animal a diet; a plethoric condition aids its development; heat-stroke, after a heavy meal, is especially apt to come on in a hot, ill-ventilated tent. But we have chiefly to do with the question of drink. This has already Alcohol. been partly entered into when discussing the march; but the subject demands a few more warnings. Sir Charles Napier, in Napier. Scinde, was fully alive to the powerfully co-operating aid of alcohol in producing heat-stroke, when he declared that the sun should have in his case no ally in drink. Alcohol even can destroy the comparative immunity possessed by coloured races; for, as Dr. Yandell states, whereas, *cæteris paribus*, the white races in Yandell. America suffer most, yet when the negro removes to the cities, and becomes loose and irregular in his habits, and eats and drinks to excess, he becomes also equally liable to sunstroke. How great, then, must be the liability of the white man, when he excesses! Prof. Maclean, again, has shown how exhaustion from Maclean. long, hot marches tends to suppression of the action of the skin and kidneys, and how powerfully alcohol aids this. De Renzy De Renzy. again warns us how any crowding in tents, most dangerous of itself in hot climates, becomes far more so when excess in the use of alcohol is superadded. Dr. Barclay has shown us how those Barclay. whose nervous system has been injured by previous intemperance are especially apt to suffer from the form of indirect heat-stroke after a march from exhaustion. In fact, the evidence is overwhelming on this point. In the Egyptian operations of war a striking example occurred. The 72nd Highlanders arrived at Suez from India on August 8. Before leaving the docks the men obtained some brandy. A powerful sun was burning in the sky. During the short march of ten miles, from the docks to the Victoria Hospital, *ten* men were knocked over by the sun, of whom one actually died on the way, and two within two days. Again, in the Bechuanaland Field Force, most stringent orders with regard to alcohol were issued. Though the temperature was 110° in double fly tents, and although many men lived in single fly tents, and the duties were most arduous, sunstroke was unknown. In the late Nile expedition the admission-rate for sunstroke was only 5.94 per 1000, and the death-rate 1.20 per 1000. The heat was intense, and the physical fatigue great, but these factors were more than counterbalanced by the healthy out-door life, and by the absence of intoxicating liquors. At Korosko in June, when cases of heat-fever became prevalent, not a single case of heat-stroke occurred. Hence, all spirituous liquors should be forbidden either before the march, on the march, or after the march. This is the golden rule. The exceptions have been pre-

viously indicated. But if ever a rum ration is deemed advisable, let it never be distributed whilst the sun is hot and high in the heavens. On the contrary, let arrangements for water be so made that a constant supply of this liquid be always at hand all through the day. In camp, in the heat of the day, let the bheesties, with their full mussacks, be at hand near or in the tents. Dr. De Renzy has shown how the comparative immunity of native troops from heat-stroke is chiefly due to the immense quantity of water they drink under exposure to the sun, "whilst the deaths from this disease among the British troops were 20 per 10,000 of strength, they were only 2 per 10,000 of native troops." Thurn has noticed in marches that when there is thirst, even if at the same time the skin be acting, that the body heat rises greatly. With a temperature of 30°–40° C. in marches, if there be thirst, the body temperature was found to rise 1° C. higher than where there was a plentiful supply of water under the same circumstances.

Water.

De Renzy.

Thurn.

Tea. Coffee.

And let the men have, as far as possible, a good ration of tea and coffee. The very action of tea is directly opposed to the action of heat. We have seen that the action of the skin ceases, or tends to be diminished, both under the coup de soleil and the coup de chaleur. Tea, on the contrary, increases the action of the skin. Heat lessens the nervous activity. Tea has a restorative action and stimulates the nervous system. Less carbonic dioxide is expired under the influence of tropical heat. Tea increases the amount of carbonic acid from the lungs. Heat will induce cardiac paralysis, whereas tea increases and strengthens the heart beat. And the action of coffee is equally potent against heat. Above all, both tend to annihilate fatigue, so deadly a factor in heat-stroke.

General Measures.—In conclusion, a few general measures may be added. Where feasible, bathing parades in the early morning tend to keep the skin in working order; but however low the sun be above the horizon, let the men wear head coverings of some sort. Should any sudden rise of excessive temperature take place, then it is advisable to suspend any intended march if possible. Again, calm, sultry days, where the sun is obscured by a thin film of cloud or impalpable dust, Surgeon-General Moore holds to be favourable to insolation. Finally, is it advisable to keep the men in their tents in camp during the heat of the day? We have seen that sportsmen go out shooting in the hottest weather without harm. Assam planters, who are compelled to go out in the sun in the hottest season and at the hottest time of the day, suffer so little from sunstroke, that the disease is said to be unknown amongst them. But, in these cases, both sportsmen and planters do not wear the regulation military helmet; moreover, they are well occupied in mind and body, and freely moving about in proper clothing. In a camp of war, the conditions are not quite parallel. Hence, we think that the best prevention of heat-stroke during the hot hours of the day is to secure a freely ventilated tent, cooled down by

some of the means indicated, and to let the men remain in such a tent till the heat of the day be over.

Hospital Ships.—On several campaigns, as we have seen, hospital ships have been employed. It is equally necessary to keep these cool as it is to keep the tents. Mr. Ernest Hart has indicated a method by which a temperature as low as 60° F. can be easily maintained. At Suakim, the *Ganges* was anchored as a hospital ship; she carried a great ice-making apparatus, constructed on the principle of producing cold by the expansion and contraction of air. He suggests that in similar cases the cold air thus produced (far below zero) be distributed by mechanical means between decks, through the wards, by conducting pipes. Such a suggestion is worthy of consideration.

CHAPTER XIII.

PNEUMONIC FEVER. (*Syn.* PNEUMONIA.)

To devote a chapter on Pneumonia, in an Essay on Tropical Diseases, may at first seem out of place. To classify the disease with the fevers may seem still more surprising. But I hope to show that the pneumonia met with in warm countries is in one form a veritable specific fever; and that this specific fever, as regards its geographical distributions, shows a gradually increasing ratio from the Poles to the Equator. I indeed believe that all cases of pneumonia are cases of a specific fever, and not cases of a local inflammation of the lung; but as regards hot countries the form of disease to be guarded against is undoubtedly one of this nature. The idea that pneumonic fever, or pneumonia, is a disease of cold rather than of warm climates, would also seem to be not strictly true.

Shortly after arriving in India, I proceeded on service in Afghanistan, accompanying a column under General Roberts into Khost. The nights were extremely cold, hard frost prevailing; the days very hot, hotter than anything I had yet experienced. During the occupation of Khost, from January 6 to January 29, 1879, pneumonia set in amongst the native troops. The camp was situated on rice fields. A very severe epidemic of pneumonia especially affected the 21st P.N.I. Some thirty men were in hospital. Shortly after arrival in Khost, the battery to which I was attached, strength 120, became affected. Six cases came into hospital with the disease within a day or two of one another; of these five died. Subsequently, in 1883, I again had frequent admissions for pneumonia. The disease also, as observed by me, had pecularities in its clinical course; for instance, the onset of the physical signs in the lung occurred frequently much later than in Europe.

A remarkable instance of epidemic pneumonia was communicated to me by a former Commandant of the 1st Punjab Infantry. In 1875 the regiment was marching into Dera Ghazi Khan, on the frontier; it was seized with pneumonia, thirty men dying out of a strength of 550. The deaths occurred about the end of March, and were distributed over a short space of time. Again, the 5th P.I., on marching out of this station to Kohat, suffered from a like epidemic. Dr. Costello, in charge of the 5th P.I., believes the epidemic arose from the regiment having come through districts in which at the time bovine pleuro-pneumonia prevailed.

Relation of Climate to Pneumonia.—During the last few

years the idea of pneumonia being a specific fever, with a local manifestation in the lung, has been gradually gaining ground. I have come to this conclusion from my experience in India. But for the present granting this, is pneumonic fever a disease likely to be met with in warm countries? Is it not rather a disease of cold climates, and, if so, what is the necessity for entering into the subject in a work limited to the tropics? In his monograph on pneumonia, Dr. Green states that, "conditions of weather and climate are probably the most important of all known agencies in the causation of pneumonia;" and further, that "pneumonia is much more common in temperate climates than in those regions which are characterized by great heat and extreme cold." Dr. Bristowe also states that, "it is more common in temperate climates." And such was my belief until I came to India. In India, however, I found pneumonia to occupy a relatively high ratio in hospital practice. Amongst the comparatively few cases of any kind or interest that the regimental surgeon has to treat in this country, pneumonia may occupy a leading position. These impressions have been confirmed by a valuable paper on the prevalence of pneumonia in hot climates, by Dr. Sanders. In the paper, Dr. Sanders shows by statistics that, "pneumonia, other things being equal, increases uniformly in frequency the nearer we approach the tropics. That is to say—and the fact is a surprising one, and one distinctly opposed to its presumed dependence on cold—the disease is more frequently met with, and is more common, in warm than in cold climates, and in hot than in warm climates, showing a gradual increasing ratio from the Pole to the Equator." This fact is, however, qualified by *extreme* nearness to the Equator. Sanders finds that after a certain parallel is reached it again becomes less common. Other relations with the tropics are found to exist. The nearer we approach the tropics the higher is the death-rate. A high mean annual temperature gives a high death from pneumonia. Statistics for warm climates show an average of 1.70 deaths from pneumonia for each 1000 of the population, based on the returns of 157 cities; whilst the returns of 15 cities in the temperate zone give an average of 1.31 deaths from pneumonia per 1000 of population.

Green.

Bristowe.

Sanders.

Sanders sums up these points amongst others as follows:—

Summary of Sanders.

1. There is a direct, positive, and unequivocal relation between the mean annual temperature of a place and its death-rate from pneumonia; the rule being that a high mortality from the disease coincides with a high mean annual temperature.

2. Pneumonia, all other things being equal, increases in frequency the further we advance from the polar regions towards the tropics; this, however, only to a certain parallel, beyond which it seems to become less and less commonly met with, until at or near the equator it apparently disappears.

Etiology of Pneumonia.—The old idea of the exciting agency of "cold" is, we think, erroneous. Sanders finds a positively decreasing ratio of pneumonia as we ascend in height. He also shows that "wet" does not heighten the pneumonia rate, and

Cold?

Wet.

demonstrates that the very lowest numbers of the disease, out of ten years' observation, have followed weeks of excessive rain. Again, were it true that pneumonia was directly related to cold, it would necessarily follow that, with a low mean temperature, the pneumonia rate must undoubtedly be high. Sanders, as we have seen, has shown the contrary. But, if we consider pneumonia to be a specific fever, with its local manifestation not a rash, but a lobar inflammation of the lung, and if such a fever be caused by an organism, we can understand the increased frequency of such a fever in hot countries, and we can also understand the disappearance of the disease at the Equator. For the heat rather than the cold will favour its growth; whilst the extreme heat of the Equator will kill it equally with cold. Now, the existence of the pneumonia organism is, I think, proved both experimentally and clinically.

The pneumonia organism.

To Dr. Friedlander belongs the merit of having clearly established the organism of pneumonia. In 1875 it is true that Klebs first found micrococci in cases of pneumonia, whilst Eberth, a little later on, pointed out their specific characters. Next, Koch, in 1881, gave an account of them. Then came the papers of Friedlander, a paper the result of long previous work, showing the constant presence of micrococci in the alveolar exudation of croupous pneumonia. Subsequently, he and Frobenius, from an examination of fifty cases, established their constant presence; whilst by inoculation and inhalation experiments on mice and guinea-pigs, he established their causal relation; for he found no pneumonia to follow his control experiments in which he first sterilized the inoculated particles. The remaining experimental link has been also supplied by Friedlander who, after failing at first to find any organisms in the blood of his patients, at length discovered them by cultivating their blood on sterilized blood serum.

Finally, Talamon of the Hôtel Dieu, Afanasieff of St. Petersburg, and Maguire of Manchester, have all confirmed Friedlander's observations.

Clinical evidence.

In addition to this laboratory evidence, other support has been afforded to the view we are advocating. M. Germain Sée holds that the epidemic form of pneumonia should be classed amongst the acute infectious diseases, and that "cold" has no etiological influence. He gives an instance in which a whole district was invaded by it. Dr. Flindt, at the International Medical Congress at Copenhagen, gave the results of his researches, extending over a long series of years. He showed how atmospheric conditions of "cold" had no relation with the disease: in only *eight per cent.* of his cases could he demonstrate any exposure to cold, whilst in *ninety-two per cent.* it was excluded altogether. He also showed the important feature, that pneumonia never appeared equally spread over the population, but always in small local epidemics—often purely domestic. A considerable number of cases were shown to follow one another like links in a chain; so that he had come to the conclusion that intercourse between the healthy

and sick played an important part in the spreading of the disease. Again, Dr. Osler, of Philadelphia, in 1884, showed, from a considerable body of evidence, the occurrence of pneumonia in an epidemic form, and affecting certain localities such as barracks. Dr. Bryson, also, many years ago, described in 1860 epidemic pneumonia occurring in the Mediterranean fleet. He especially remarked on its resemblance to the pleuro-pneumonia of cattle, and believed that the sick landed from the fleet at Malta communicated the disease to other patients in the hospitals.

Emmerich's case.

But the best proof of the specific nature of pneumonia, uniting both the pathological and clinical evidences, has been afforded by Emmerich, of Munich. A certain prison at Amberg had, for a long series of years, been constantly the theatre of pneumonia. After an exhaustive process of exclusion, Emmerich examined the material filling up the interval between the floor of one room and the ceiling of the room below it. This material, by culture experiments, showed the presence of Friedlander's micrococcus.

Summary.

There can, then, be no doubt of the existence of an epidemic form of infectious pneumonia. I look upon this disease as an acute fever. Why pneumonia at one time should spread, and at another time not do so, we can no more explain than we can similar facts with other acute exanthematous fevers. In cattle, two forms of pneumonia are found: one sporadic, the other epidemic and highly infectious; and no one, we presume, doubts that the pleuro-pneumonia of cattle is a specific disease. Now, I have before shown its increasing frequency and mortality the nearer we go to the Equator within certain limits of the same. Hence, therefore, the necessity of indicating its prevention in tropical campaigns.

Occurrence in Campaigns.—In the China war, of 1860, pneumonia was prevalent to a large extent. In Ashanti, pneumonia formed one of the chief diseases. In the late campaign in Egypt respiratory diseases formed 4.8 per 1000.

Besides the cases that fell under my notice in Khost, Sir Thos. Crawford also drew attention to the prevalence of a peculiar and fatal form of pneumonia in the Afghan war. Finding this to occur chiefly in soldiers with a malarial history, he suggests that it occurred here as an expression of malaria. The cases, however, that fell under my notice, affected men equally with or without a malarial history. The men of the battery, moreover, had but a slight malarial past history.

Selection of Men.—Sir Thos. Crawford, nevertheless, founded his opinion on a general review of the cases, and presuming this form of pneumonia is more likely to attack men with a malarial history, we have another reason, to those already adduced, for excluding all men with a bad malarial medical history, from taking part in a campaign.

Selection of Season.—From a perusal of the medical histories of past tropical and sub-tropical campaigns, we find that, with respect to pneumonia, the chief season to avoid is the hot, muggy weather of the rains. In China, for instance, pneumonia became

prevalent during the heavy rains and hot, muggy weather of May. The Loodhiana regiment was especially affected at this time, having a very large number of sick from the disease.

Camp.—A moist site is to be avoided as much as possible. The above regiment was encamped on a moist plot of ground. In Khost, the regiments were encamped on rice fields to a great extent, dried up, it is true, at the time. The measures already indicated for drying a camp under malaria are to be followed out.

The most important measure of all is the oft-alluded-to free ventilation of the camp.

The nature of the soil is far less important. The epidemics that have occurred on the frontiers have not occurred where the soil was moist, but rather the contrary.

Food.—There must be no deficiency of albuminates in the food, as any such deficiency has been found to predispose to pneumonia. Alcohol is here, as elsewhere, strongly contra-indicated. In the Bechuanaland Field Force not one death occurred from pneumonia until the canteens were reopened, when mortality arose among the men affected, many being depressed with drink.

Protection at Night.—Of all duties, night duties have been found most to predispose to pneumonia in hot climates. Hence, here are indicated also the precautions already pointed out under malaria and bowel complaints, as regards protection of sentries, clothing, and sustaining food.

Treatment of an Epidemic.—Should the disease become epidemic, we must, imprimis, see that there be no overcrowding, particularly in hospital. In all the reports of such epidemics it has been found that overcrowding has played a considerable part.

No overcrowding.

Putrescent organic matter doubtless forms a pabulum for the special organism, and such organic matter will accumulate, exhaled from the lungs, where this overcrowding occurs. Hence, "dislocate" the camp.

No intercourse.

From what we have seen from the instances adduced by Sée, Flindt, Osler, and Bryson, all intercourse between the healthy and the sick must be prevented.

Disinfection.

Sputa.

Particular attention must be paid to disinfecting the sputa of the sick. They should be burnt, or else received into a cup containing a disinfecting solution. For this purpose corrosive sublimate (2 drachms to the gallon) or chloride of lime (4 ounces to the gallon) are indicated.

Tents.

All tents are to be disinfected likewise when vacated. All rooms at the base hospital should be similarly treated.

Clothes and bedding.

Inasmuch as the sputa may have lodged on the clothes and bedding, or the organism may have also attached itself here, disinfect also the clothes and bedding.

Inoculation.—In the epidemic of pleuro-pneumonia of cattle, it was at first thought that protection could be obtained by inoculation; but further experience has negatived this. Hence, in any extensive epidemic occurring in man, no prevention can be hoped for on these lines.

Examples of Epidemics.—As an illustration of an epidemic,

and of the course to be pursued, the following instance, which lately came under my care, may be cited. It is true this epidemic did not occur in the field, but the treatment employed may be served as an example of the line of treatment to be followed in similar cases.

On November 26, 1885, the 23rd Pioneers arrived from the Pishin Valley from Umballa. From November 29, 1885, up to April 26, 1886, thirty-three cases of pneumonia occurred. By months, they were thus distributed:—Four cases in November 1885, nine in December 1885, five in January 1886, five in February 1886, five in March 1886, five in April 1886. Various causes were assigned during the epidemic for the disease. Thus, it was stated that the regiment was inadequately clothed, and that the men caught cold. Those holding this theory were entirely ignorant of the way in which the regiment, as a matter of fact, was clothed; for probably no regiment in the native army is better provided in this respect. In addition to the ordinary dress of the native soldier, each man, among other things, had been provided, before starting for Pishin, with a thick sailor's jersey. Secondly, it was held that the regiment had returned broken down in health from Pishin to Umballa. The following was the daily admission-rate for the regiment for the years 1881, 1882, 1883, 1884, 1885, and 1886:—In 1881, 39.65 per 1000; in 1882, 37.29 per 1000; in 1883, 22.53 per 1000; in 1884, 18.55 per 1000; in 1885, 31.41 per 1000; in 1886, 19.62 per 1000. Now, the admission-rate for 1885, at first sight, certainly seems greatly in excess of that for 1883 and 1884, but, on examining the factors of this rate, the following circumstances are evolved:—The great bulk of the regiment was in the Hurnai Pass up to April 18; from April 18 to November 16 the regiment was in the Pishin Valley; from the latter date it travelled to Umballa, reaching the latter station on November 26. Now, on analyzing the daily admission-rate, I found that the rate of the head-quarters admissions from January 1 to April 18 was 25.74; and from April 18 to November 26, 19.61; from November 27 to December 31, 39.40. Hence, the large bulk of admissions occurred when the regiment had returned from Pishin, whilst in Pishin the admissions were only slightly above those of the previous year, the remaining portion of admissions being made up by that of the depot. Thirdly, it was held that a white fog that prevailed about the lines in January caused the disease. Now, a somewhat similar factor was alluded to by Sir Guyer Hunter in relation to the cholera in Egypt. A yellow fog was stated to have been present at the time in the district. If, then, a yellow fog could have some causal relation to cholera, might not a different species of fog—namely, a white fog—have a like relation to the pneumonia. But, inasmuch, the first supposition is negatived by the fact that cholera occurs where there is no yellow fcg, so, in our cases, the pneumonia continued albeit the white fog had disappeared. Fourthly, the cold from December to February might have caused it. This, however, could not have caused the cases

later on. The temperature was taken in my hospital three times a day, with the following results:—

Case. No.	First Day of Illness.	Temperature in Hospital on First Day of Illness.		
		6 A.M.	12 NOON.	6 P.M.
1	...	Not taken		
2	...	"		
3	...	"		
4	...	"		
	1885.			
5	Dec. 6	57°	64°	65°
6	" 6	57°	64°	65°
7	" 7	55°	62°	64°
8	" 6	57°	64°	65°
9	" 6	57°	64°	65°
10	" 8	56°	61°	64°
11	" 9	59°	64°	64°
12	" 10	57°	63°	64°
13	" 15	56°	64°	64°
	1886.			
14	Jan. 3	52°	55°	55°
15	" 11	54°	61°	59°
16	" 21	56°	61°	59°
17	" 21	56°	61°	59°
18	" 31	52°	58°	59°
19	Feb. 3	48°	54°	58°
20	" 9	50°	60°	69°
21	" 15	55°	65°	64°
22	" 23	55°	65°	69°
23	" 22	51°	62°	50°
24	March 2	59°	71°	70°
25	" 4	61°	71°	70°
26	" 15	66°	75°	74°
27	" 25	67°	75°	74°
28	" 30	73°	80°	79°
29	April 4	62°	75°	73°
30	" 6	65°	76°	74°
31	" 14	76°	84°	83°
32	" 18	75°	88°	88°
33	" 26	78°	94°	92°

Looking at this table we find that at 6 A.M. the temperature ranged from 50° to 78°; at 12 noon from 55° to 94°; and at 6 P.M. from 55° to 92°, during the period of the epidemic of pneumonia, or with ranges at these hours respectively of 29°, 40°, and 38°. The range would also be much greater in the men's lines, as there the protection from heat and cold would be less. As the cases continued to come into hospital, my conviction that we had here a specific infectious fever became more and more strengthened, and in April I recommended that the men's lines be evacuated and disinfected. This was accordingly carried out; the men moved out into tents; the lines disinfected with sulphurous acid for six hours, every aperture being closed up, and, on the day following the fumigation, freely ventilated. On the third day the men re-occupied them. By April 14 all the lines had been so treated except those of the band. On April 14, Case 31,

that of a musician, occurred. On the 15th, the band went into tents. Two cases subsequently occurred, one on April 18 in the married lines, the other in the band lines on April 26. Both these cases occurred nine days after the lines were re-occupied or eleven days after they had been evacuated for disinfection. But if pneumonia be a specific infection fever, a period of incubation will be present as in other specific fevers. This period, it is not too much to assume, may be as long as eleven days or more, and thus the disease was actually caught before the lines in question were evacuated. That such was the case obtains support from the fact that during all these months measles had been present in the married lines. Subsequent to the disinfection three cases occurred, two on April 17, in lines disinfected on the 13th, and the third within a week from the disinfection. Now, the incubation in measles is stated to range from seven to twenty-one days. Hence it is probable that all these cases were beginning, as regards incubation, before the lines were disinfected. After Case No. 33, no more occurred.

The following summary of facts, culled from the clinical history of the thirty-three cases, shows also that the disease was one of a specific nature rather than of a local inflammation of the lung.

(1) *Date of Appearance of Physical Signs.*—If the affection had been a simple local affection of the lung, it is probable that there would have been some uniformity in the date of appearance of the physical signs. The physical signs ought to be present surely on the first day if the fever results from a local lung inflammation.

Now in twenty-three cases, where only one lung was affected, the physical signs appeared first on the second day in five cases; on the third day in seven cases; on the fourth day in three cases; on the fifth day in four cases; on the sixth day in one case; in three cases the date was not noted.

(2) *Different Conditions of the Lung present at the Return to the Normal Temperature.*—If the pneumonia had been a simple local inflammation, then, when the normal temperature had been attained, the local condition of lung should be generally of the same nature, indicating a subsidence of the inflammation; but this was not the case in these cases. Thus, in twenty-two cases in which the condition was accurately noted on the day on which the temperature fell to normal, the lungs were found in the following stages of inflammation:—In the first and second stages, in three cases; in the first, second, and third stages, in one case; in the second stage, in three cases; in the second and third stages, in ten cases; in the third stage, in five cases.

(3) *If the affection had been merely a local one, then, on the return to the normal temperature, the lung should quickly be found cleared up;* but this was not the case, for signs indicating the first and second stages were present in one case nine days after the return to the normal temperature. Signs indicating the second stage were present in six cases, three, four, seven, seven, eight, and fourteen days after the return to the normal temperature; signs indicating the second and third stages were

T 2

found in one case, eleven days after such return; whilst signs of the third stage were found in ten cases, on the second, third, fifth, sixth, sixth, sixth, seventh, twelfth, sixteenth, and nineteenth days. If, however, we consider the lung affection as merely a local expression of a specific fever, then there is no necessity for the local affection to have ceased at the return to the normal. Peyer's patches are not normal in enteric when the temperature has become normal; they begin to heal usually in the fourth week, and each patch requires about fourteen days to heal.

(4) *Examination of the Cases of Double Pneumonia in the Series shows the following facts in those in which the Second Lung became inflamed subsequently to the first.*—In Case No. 2, the right lung became affected on the fourth day, the left lung on the seventh. Now on the fifth and sixth days the temperature fell from 106.8 (of the fourth) to 103°. But on the left lung becoming affected on the seventh day, no fresh rise of temperature occurred, on the contrary, it fell to 102.8°. In Case No. 4, the right lung first showed physical signs on the fifth day, the left lung on the ninth day, but so far from a fresh rise of temperature on this day occurring, there was a rapid fall of three degrees. In Case No. 5, the temperature similarly fell two degrees on the day on which the second lung became affected. In Case No. 16, the right lung was affected on the fifth day, the left on the sixth day, but on the third, fifth, sixth, and seventh days the temperature presented deep fluctuations of six to seven degrees having no relation to the local lung affection. In Case No. 22, the left lung became affected on the second day. On the third day the temperature fell to normal, and remained so forthwith, notwithstanding that on the eighth day the right lung became affected. In Case No. 24, the right lung was affected on the third day, the left on the fifth day, but on the morning of the fifth day, the temperature was nearly two degrees lower than that of the previous evening. Examination of these cases is very important, as contra-indicating the local theory of lung inflammation in pneumonia. For if the latter had been simply a local inflammation, then on the second lung becoming inflamed subsequently to the first, a second rise of temperature should have taken place.

(5) *Cases of exceedingly High Temperature with no Corresponding Extent of Lung Lesion.*—These cases point to the same conclusion. If the affection were merely a local lung affection, then a hyperpyrexia should indicate a very severe inflammation of the lung. But in Case No. 25, only the left lower lobe was inflamed, yet the temperature ran up to 106.4. In Case No. 4, only one lung was affected and only one lobe, yet the temperature reached 106.8. Such are a few of the clinical symptoms that supported the theory that the cases in question were those of a specific fever.

CHAPTER XIV.

YELLOW FEVER.

Yellow fever fortunately is a disease which is limited in its habitats. There are only three situations in which it is endemic —viz., the West Indies, the Mexican Gulf, and part of the Guinea Coast. There are not many campaigns, therefore, in the tropics in which it has played a part. The French suffered severely from it in their war in Mexico, and our army in the last century in St. Domingo. Still, complications are always ready to arise with savage neighbours, and our possessions on the West Coast of Africa render us liable to meet with the disease in any campaign in that region. Thus, in the war in Ashanti, the question of prophylaxis was fully entered into, but fortunately the disease was not imported. But should a future war in these regions cause the disease to be brought into our midst, we have opened to us by the labours of a distinguished savant, a means of prophylaxis hitherto denied to us.

Etiology.—The etiology of the disease is now tolerably clear, at all events, two important facts have been rendered unassailable: first, its separation from, and independence of, malaria; and secondly, its propagation by human intercourse. Its spread and origin are favoured by the congregation of persons born in the cold climates of northern latitudes, especially when newly arrived in one of the three endemic regions of yellow fever. These endemic regions have been nominated above. And from the endemic region the disease can be transported by ships to localities outside the yellow-fever zone, as we have experienced in England, Malta, and Gibraltar, and as the Spanish have experienced in their country. Hence, the first great fact to seize is its spread by human intercourse, no matter what may be the view held how human intercourse acts. Thus, a person can convey the yellow-fever poison to another without having it himself, as shown by Dr. Macdonald, in his account of the yellow fever outbreak on board the *Icarus* in the West Indies, or it can be conveyed by the sick themselves. It is generally held (Parkes, Bristowe, Billings) that the poison is reproduced in the person affected, and then given off from his body to infect others. Hirsch and Hænisch, however, hold that "man's agency is not as a producer, but only as a carrier, just as the ship is a carrier," "that the yellow-fever patient is a medium of spreading the disease only in so far as the morbid poisons clings to him as it does to other objects," such as the cargo of a ship, or a man's

Human intercourse.

effects. This great fact of human intercourse, acting for its diffusion, is the central point to hold fast to in prevention, and, holding fast to it, we must, at the same time, reject all theories of pandemic agnosticism. At the same time, the view is also the one meriting especial attention, inasmuch as the means of prevention must be especially directed to the discharges of the sick. No clearer evidence of the direct communication of yellow fever can be required than afforded by the histories of the *Anne Marie*, sailing from Havannah for St. Nazaire, in France, and causing, by human intercourse, forty-four cases of yellow fever with twenty-six deaths; of the *Bann*, *Eclaire*, &c. The outbreak, again, in September 1865 at Swansea, starting by infection from the *Hecla*, that had arrived from Cuba with sick on board of the disease, is also conclusive of this point. And, be it noted, that both the *Anne Marie* and the *Hecla* were neither subjected to quarantine, a point which we shall emphasize later. Again, in 1878, the disease came to Madrid along with the troops arriving from Cuba.

Nature of the Poison.—What is the nature of the poison? In 1873, Dr. Perry, in a paper read before the American Health Association of New Orleans, foreshadowed the nature of the poison, in that he described it to be due to a germ. He draws attention to the nature of its life-history, and insisted that though not demonstrated, yet its existence was rendered beyond doubt by the close analogy between yellow fever and small-pox, scarlet fever and measles. Dr. Perry's theoretical opinion has been vindicated, and the discovery of the "germ" has been followed by a prophylactic treatment, the success of which will be presently demonstrated.

Dr. Perry.

Yellow Fever Commission.

Again, in America, the Congressional Yellow Fever Commission of 1878–9 declared that the cause lay in a specific particulate poison, endowed with the vital properties of growth and reproduction; whilst yellow-fever patients were the most frequent cause of its spread from place to place, more epidemics having resulted from persons sick with the disease than from any other cause.

Dr. Domingos Freire.

The nature of this specific particulate poison or germ has been made out by the researches of Dr. Domingos Freire, Commissioner of the Brazilian Government. He has discovered the specific "cryptococcus," but he has done something more. Never was the scientific value of laborious bacterial investigation more completely vindicated. A brief account of Dr. Freire's researches is necessary, in order to show the grounds on which the preventive treatment of yellow fever in its modern application rests.

The cryptococcus of Domingo Freire.

A few years ago, Dr. Domingos Freire forwarded to the Académie des Sciences the results of his researches, which, however, were not so conclusive as his last. In 1883 he embodied these in a report presented to this body and to the Biological Society of Paris. His researches, carried out with the aid of M. Rebourgeon, have demonstrated by inoculation and inhalation experiments on guinea-pigs, the presence of a specific microbe;

this microbe secretes an alkaloid, resembling a ptomaine, which acts on the body as a violent poison. After attenuation the virulence of the virus is diminished, and a cultivation-liquid obtained, which, when used for inoculation, is a prophylactic against yellow fever. Freire also shows that the fungus previously described by Lacerda in the vomit and urine of yellow-fever patients, is but a chance parasite, having no connection with the disease.

These results of Domingos Freire have, it is true, been called in question by Messrs. Moxley and Harrison, of Barbadoes, but as these latter gentlemen have been prohibited from continuing their investigations on the subject by secular authority, on the ground that "such inquiry was valueless, and dangerous to the public health" (!) their investigations cannot be said to have reached finality.

The remaining points, favouring and predisposing, will be now indicated in our analytical measures for prevention.

Selection of Men.—Inasmuch as new arrivals from northern latitudes are those most predisposed, and as this predisposition of white men increases in proportion as they live further from the yellow-fever zone, it is evident that our army starts heavily handicapped. As far as acclimatization can help our troops we can do but little in the way of selection. Parkes recommends that all troops, before going to the West Indies, should have had three or four years' service in the Mediterranean; this principle, again, should be extended by selecting, for a campaign on the West Coast of Africa, troops who have already resided in the West Indies. Still it would appear that we do not obtain more prophylaxis perhaps than such as would be given by a residence anywhere in the tropics. Comparative immunity, Hirsch states, is only obtained by a residence of many years in a locality constantly visited by the disease, or by having passed through an attack; whereas, if the individual has simply resided within the yellow-fever zone, but at a place rarely or never attacked, the predisposition is not diminished in greater degree than by a residence in the sub-tropics or tropics generally. Nay more, many hold that the immunity obtained by acclimatization is only valid for the locality where such immunity was acquired, "so that it vanishes with a change of residence, even when that does not involve conditions essentially worse than those left behind." There is danger, for instance, in removing European troops from one island of the West Indies to another. Cornuel has pointed out if two bodies of troops mutually exchange stations at different points of the Antilles, both bodies being free from the disease at the time of exchange, that, after the exchange, cases of yellow fever will shortly break out at both places, without there having been the slightest change in the conditions of the locality. Thus, all we can do is to select regiments who have been for some time serving in the tropics.

We can, however, select West India Regiments for service in the yellow-fever zone; here we shall have either creoles or pure

blood negroes. Creoles have but a relatively acquired immunity, resulting from their having resided for years in the yellow-fever zone, or a more perfect immunity from having passed through the disease in childhood. The pure-blooded negro, on the other hand, has a congenital immunity, even those who have not been acclimatized in the yellow-fever zone possess immunity, "which immunity is all the more complete, the more purely the racial characteristics of the individual have been preserved." The importance of employing negroes was well shown in the French Mexican campaign. Regnaud and Bouffier point out that, among the 500 negroes from the Soudan and Nubia—regions free from yellow fever—who accompanied the French Army to Mexico, and were all the time in the yellow-fever zone there, not a single case of yellow fever occurred, whereas the French and Mexicans were decimated by the disease.

Selection of Season.—Although within the endemic regions yellow fever occurs at all seasons, yet it is chiefly sporadic in the cold weather. The choice of season is a most important one.

Avoid hot and rainy seasons.

The hot and rainy seasons are those to avoid. The greatest prevalence has been shown to fall from April to September. Bouffier shows that, in the course of thirty-two years, there were received into the Marine Hospital at Vera Cruz 6491 cases of yellow fever; of these, 5123, or 73.8 per cent. of the whole, were admitted from April to September. Much the same selection is shown by Hirsch for the United States, July, August, and September being the months chiefly affected.

Temperature.

The two chief factors of season are, then, those relating to temperature and moisture. The isotherm of 20° C. (68° F.) is necessary for an epidemic. Yellow fever lasting all the year round is only found in those regions where the lowest mean temperature is at least 20° C., as in its endemic homes; and in these regions it does not become epidemic until the hot season. Again, in regions—higher latitudes—where the isotherm is less than 20° C., yellow fever only becomes epidemic when the temperature attains that of the tropics; and here it is principally in the hot season that it so occurs; whilst, finally for Europe, the disease has only occurred in the hot season, and has never become epidemic in a temperature below 20° C.

Moisture.

The second factor is the amount of moisture in the air, and the rainfall. Hirsch shows that the disease occurs either not at all, or only to a slight extent, in years with little rain; and that this is equally the case in the tropics, where the disease always develops on the setting in of the rains or directly after their cessation, as in the extra-tropical region of the yellow-fever zone.

Thus we see the season for campaigning, to avoid yellow fever, is the cold season.

These factors of heat and rainfall were well exemplified in the epidemic in Barbadoes in 1881. From 1839 to 1861 outbreaks of the disease had occurred every second and third year. Then, in consequence of great sanitary improvements, such as the inauguration of an excellent drinking-water, better sewage arrange-

ments, &c., there was no epidemic till 1881. In this year the intensity of the heat was very remarkable, and after June extraordinary heavy rains set in; these factors, combined with others, determined an outbreak.

Finally, the relation of season was pointed out by the Havana Yellow Fever Commission of 1879–80 by Dr. Chaillé. The Commission held that the poison had only a limited time each year for its reproduction, and that within the tropics it manifested an annual tendency to die out. Hence we have to choose the period when the reproduction ceases, and this is the cold season.

Clothing.—In yellow fever, again, as in all other tropical diseases, the necessity of woollen and flannel clothing is apparent. It seems most essential to prevent chills in this affection. It has been found that the immunity of black races even disappears should the action of the skin become checked by a chill. The acquired immunity is doubtless due to their having become immune to the effects of fæcal effluvia containing the poison, by their secretory organs adapting themselves to the environment, and eliminating the poison; should a chill occur, this eliminatory action will cease. And if this be the case with the black races, how much more with our troops?

Marching.—Fatigue under exposure to a hot sun, here as elsewhere, predisposes to the disease in the endemic regions. Hence, here again the early morning march, the early ante-marching ration, and the regular halts in a not too prolonged march, are indicated. But yellow fever may break out on the line of march. At once isolate the sick, and if the military situation permit, strike out a new line more or less at right angles to the direction in which the source of the infection exists; whilst the conservancy indications to be narrated are to be strictly carried out.

The Camp.—As regards the question of camps, we have one element in the pathology of yellow fever decidedly in our favour, and that is its *local* character. The disease is especially associated with the sea-coast and the immediate shores of rivers. It is but rarely that the disease penetrates into the interior; exceptions have happened, but only rarely. And should the disease occur inland, in the endemic regions, it will but rarely assume an epidemic form. Again, the disease, as a rule, affects the plains, and has a tendency to be checked by elevation. No precise statements can be given as to the altitude necessary to check it, as it has been observed at very high elevations: for instance, at Cuzco in Peru, at 11,378 feet (Joseph Jones). The great indication is to leave the shore of debarkation as soon as possible, and reach the uplands. Again, the geological nature of the soil gives us no indications, for the disease has affected the most various formations. The condition of the locality as regards its sanitation is the most important factor in relation to camp, in addition to situation on the shores of the sea or rivers. We can well imagine how it would have raged at Cape Coast Castle in the Ashanti war had it been imported, for Cape Coast Castle was especially

exposed to it, not only from its geographical position, but from its filthy condition. Here were all the forcing conditions at hand for its spread: overcrowded, unventilated buildings packed closely together, refuse of all kinds in the unscavengered streets, pigs freely defiling the thoroughfares, ordure deposited anywhere, stagnating drainage, and overhead a tropical sun. In addition, the custom of burying bodies in shallow graves inside the houses, or in the yards attached to them. Hænisch again draws attention to the danger of location along the shore, washed by the refuse of ships and houses that has been discharged into the sea and exposed to a tropical sun.

Finally, a new source of danger has been shown us by Dr. Domingos Freire in camping on such sites. We have seen that yellow fever especially locates itself in the low-lying quarters on the sea-shore. Now should any expedition lead our troops to debark at a spot where yellow fever has raged, the troops must, as fast as possible, leave the shore for the country behind, leaving as small a garrison as possible, for Dr. Freire has found the organism actually present in the soil. He examined some earth from an excavation in a street in Rio Janeiro, and found the characteristic organism—a matter not surprising, as the epidemic had spread all over the city. He again examined some from the Janjuba cemetery, in which were buried those who had died from the fever, and found the organisms in still greater quantities. He diluted the earth and inoculated guinea-pigs with it, and affirms that he produced yellow fever thus. Hence, do not encamp near cemeteries. Thus, further, we see that we should move our troops as quickly as possible away from the shore of debarkation, and from the port of debarkation, and attain the open country, for the farther we go inland, the less will the danger of yellow fever become. This was well exemplified in the French war in Mexico. Transport was scarce, and the army could not move up from the "terre caliente" to the first ridge of uplands. Had they been able to do so, they would have escaped the disease. The lesson is obvious. Some troops, however, must remain to secure the base. The greater part might be kept on board ship, close at hand, for any eventualities. For those on shore much may be done in the way of conservancy, as will be pointed out later on. Meanwhile, there are certain general rules for camps on the shores of endemic regions, and for camps, generally, in relation to yellow fever, that are to be strictly carried out. After conservancy, the next important proviso is to guard against great density of the population in camp. The predilection of the disease for towns, and particularly for populous towns, shows this, as does also the freedom from it of open country districts. Hence, let the camp be in as open order as possible. Next, drain the camp. The great improvement in Barbadoes as regards visitation of yellow fever, was doubtless in part due to the drainage measures that had been carried out. Attend to the ventilation of the camp; and should the locality permit, arrange that the tents and camp generally be so related to any neighbouring

hills, as to be protected from south and west winds; or, on the contrary, that these be exposed to north and east winds, for Hænisch points out that the above winds respectively favour and restrain an epidemic.

Should it be necessary to disturb the ground for the laying out of the camp, this must be done as little as possible, and some time must elapse before the site is occupied. In 1881, at the time of the great epidemic at Barbadoes, amongst other factors, the railway was being made, and extensive cuttings were in progress. It was found that even the European officials died who were in camp away from the native filth, and it was supposed that the disturbance of the earth caused them to inhale the poison. From what has since come to light by Freire's researches, we easily understand how this would happen.

Finally, should our men be located at the base in any buildings, let them avoid the ground floors, and only inhabit the upper; after having first cleansed the buildings, as pointed out under the head of disinfection. Keep the men away from all ground emanations.

If camp attacked? Evacuate.

Should the disease, notwithstanding, attack the camp, at once evacuate it. The medical history of Guiana shows that, even in a highly malarious country, yellow fever may be evaded by change of ground, although the men are obliged to encamp on a swamp. In 1861 yellow fever broke out at George Town on the 26th of May, chiefly among the shipping. The troops were at once moved inland and put under canvas. During the first sixteen days after their arrival in camp, seven cases occurred; the disease then ceased amongst the troops, though it continued to prevail in George Town till the end of December. As Roth tersely puts it, "dislocate the troops."

"Dislocate the troops."

Water.

Food.—The water supply must be scrutinized with the utmost care, and all the precautions already indicated be undertaken. It is highly probable that yellow fever can be propagated in the same manner as cholera and enteric fever, by the poison getting into the drinking-water. We have not only indeed to secure that there be no fæcal contamination of the water, but we have to take measures against the chance of the water containing the poison when obtained from any source in endemic regions, inasmuch as the "germ" has been shown to reside in the earth. The twenty years' exemption in Barbadoes was greatly due to the new and excellent water supply. Previously the inhabitants drank brackish well-water.

Temperance.

Again, strict temperance is to be rigidly provided for. If possible, red wines, as containing tannin, are especially indicated, and would tend to precipitate any poisonous material. Excess of alcohol has always predisposed to the disease. Barton, in a statistical collection of the fatal cases in an epidemic extending over two years, emphasizes the fact that, of the Sons of Temperance only 29 died in a membership of 2427, and a general mortality of 5653.

Finally, here or elsewhere, the food must be inspected. Horton

draws attention to the predisposing effect of unwholesome food in the endemic region. And here, also, as elsewhere, the men must have a proper and adequate ration suitable to the work performed, so to eliminate or make good the effects of fatigue.

Night Protection.—It would seem that there is especial danger at night as regards yellow fever. Allowing the organism to reside in the soil, we should have the same rationale of this fact, as in the case of malaria. All imprudent exposure at night predisposes to the disease. Lawson draws attention to the fact that the "emanations" from the localities containing the yellow fever poison, are, during the night, rapidly diffused upwards, and can be carried to a considerable distance by currents of air; and if sufficiently concentrated, can then cause the disease amongst the persons exposed to them. He recommends also that the men sleep as high above the ground as possible. Hence, for the men generally, and for those on sentry duty, the same line of action is indicated as laid down under Malaria.

Mosquitoes. Finlay.

The researches of Dr. Carlos Finlay, of Havana, indicate more especial precautions at night. This physician shows that the disease can be communicated by the mosquito. A short account of his work may therefore be given. There are two species of mosquito in Havana, one entirely nocturnal, the other diurnal and crepuscular, appearing early in the morning, again between 9 and 10 A.M., and again in the afternoon, until as late as 11 P.M.; in dark, ill-ventilated rooms, it may be present the whole day. The experiments were made on this latter form, as it was found capable of stinging as often as the digestion of the blood previously sucked up was completed; whereas the first variety can only sting once. The sting is a hollow needle, with its sides roughened by external ridges, and its point armed with teeth. It often retains spores of microscopic fungi, both inside and out. Hence the sting impregnated with animal juices during the operation of stinging may form a fit soil for the preservation or culture of the germs.

In his experiments, Finlay first caused the mosquito to sting a yellow-fever patient, and then to sting and thus inoculate an individual who had not as yet suffered from the disease. Twenty-four men were thus experimented on, with the following results:—Two having left the country were lost sight of; six, within the ordinary limits of yellow-fever infection, had an attack of fever, the exact counterpart of a mild attack of yellow fever, which was proved by subsequent observations to have conferred immunity; eleven others, without having any morbid manifestations from the inoculation, appear to have gained immunity, as they lived from two to three years constantly exposed to the disease, in Havana, without infection; finally, of the remaining five, in four no immediate result followed, but at the end of several months, a mild, non-fatal, attack of yellow fever supervened, whilst in one, death from malignant yellow fever occurred seven months after, there having been no result directly after the operation. Amongst these inoculated subjects were five soldiers: of these,

three had fever, diagnosed as regular yellow fever, or abortive yellow fever, whilst the two remaining had "slight fever," but were not laid up. The inoculations were performed in the interval from June 29 to August 31, 1881, and the cases were watched till the end of 1885. Though exposed to infection, they remained uninfected.

The arguments in favour of the mosquito being an agent in the transmission of the disease are as follow:—The limits of its functional activity correspond in temperature and altitude to limits of yellow fever, for, as regards temperature, it thrives best ranging from 60° to 100° F., and as regards altitude, from the level of the sea, to 3000 or 4000 feet. Now most observers place the limits of temperature for yellow fever to range from 60° to 90° F., although a general temperature of 32° F. has proved ineffectual to prevent the recurrence of the disease when a tropical temperature was produced. Again, the highest altitude at which the disease has been observed is 4000 feet. Mosquitoes are rare in Havana when the temperature is below 70° F.; they are most frequent from May to October. In 1885, however, there occurred an exception to this general rule, the insects being most frequent from the latter part of September to November. Now, in this year, there was a remarkable scarcity of yellow-fever cases in the summer, most of them occurring in November and October.

Every mosquito that stings is already fecundated. After stinging it lays its eggs on some water; these are hatched in two to four days, and in two to three weeks after the egg is laid the fully developed mosquito is produced. Thus, a single infected mosquito conveyed to a healthy locality with an appropriate altitude and temperature might inoculate the disease to any amount on any liable subject; and, according to the usual rates of incubation, at the end of two to three weeks the consequent attack of yellow fever would be at its height. In the meantime, the imported insect would have produced a whole brood of its species in the vicinity of the place where the patient was lying, thus providing the necessary conditions for the continuation of the disease. Dr. Finlay holds that yellow fever is communicated by inoculation, and only becomes epidemic when such inoculation can be brought about by some external natural agent, such as the mosquito. He holds, finally, that the disease is incapable of propagation where tropical mosquitoes do not exist, or are not likely to exist; inasmuch as it ceases to be epidemic at the same limits of temperature and altitude that are incompatible with the functional activity of the insect, while on land it spreads readily wherever they abound: whilst, as by the inoculation experiments detailed above yellow fever has been brought about, he infers that the mosquito is the habitual agent of its transmission. That the disease can be produced by inoculation was shown by Carmona of Mexico in May 1885. He inoculated Carmona. six prisoners with the dried residue of yellow-fever urine. In two cases the local symptoms of inoculation were immediately

followed by those of fatal yellow fever, and both died on the same day.

Such being the evidence, the use of mosquito curtains is indicated for all who can obtain them. In default, an application of creasote and oil, or carbolic acid and oil, for the face and hands, should be given in cases where the disease is present.

Conservancy.—There is not the slightest doubt but that yellow fever stands in direct relation to filth, and decomposition in organic matters. It haunts the low and filthy quarters of seaports, the vicinity of foul drains, and in ships the foul holds thereof. In the report of the epidemic that occurred in Charleston, in 1858, the physicians of the place stated that the districts infected by yellow fever had increased just in proportion to the neglected public hygiene. These conditions in civil life teach us to enforce strict conservancy in military campaigns in the endemic regions, or in regions where the disease has been imported. In the War of the Secession, the exemption from yellow fever enjoyed by New Orleans was attributed to the "despotically" conducted improvements in public sanitation. Sanitary regulations were enforced with great rigour, and no yellow fever resulted, whilst at Port Royal were undrained reservoirs of sewage, and yellow fever commenced and prevailed there.

Billings.

Dr. Billings, of the United States army, thus epigrammatically puts the question regarding filth:—"So far yellow-fever cities and yellow-fever ships have been filthy cities and filthy ships. Whether the disease would spread in a clean, well-drained city we do not know, as there are no such cities in the yellow-fever region."

Creighton's views.

Dr. Creighton, moreover, traces the origin of yellow fever from filth in a more direct manner. He points out that there is only one circumstance covering its history, geography, and remarkable changes in distribution, and that is, the slave trade. The advent of yellow fever into the world coincided with the rise of the slave trade; its habitat is, or has been, the ports of debarkation of the slave trade; its exacerbations have coincided with the most lawless period of the negro traffic. Finally, it has been eradicated in the great cities of the Atlantic seaboard after the importation of negroes ceased. Following Audouard, yellow fever is considered to be a peculiar form of typhus originating at all the endemic centres in the filth of the slave ships.

Thus, the first indication is to clean up the filthy quarters, if present, at the point of debarkation. Let a permanent sanitary committee be appointed, as was done in the Ashanti war, for this purpose, in view of the importation of yellow fever. There must be the most thorough cleansing and disinfection. Secondly, our own camps must be kept likewise in the most rigid state of cleanliness.

Ashanti war of 1873.

Quarantine.—Next, quarantine must be enacted. As an example of preventive measures, we have the Ashanti war of 1873. Yellow fever had, it is true, never been seen at Cape Coast Castle, but both north and south of this place it had appeared periodically, especially, of course, in its endemic home, Sierra Leone. Now, it

was considered quite probable that the disease might appear at Cape Coast Castle, from the geographical position of the latter, and from its filthy condition. Its immunity up to date was probably in great measure due to the small white element among the inhabitants, as it was pointed out that Rio Janeiro and Buenos Ayres had likewise both escaped infection until a lively commercial intercourse had arisen. But, with the army of invasion, the environment was altered: for, by the arrival of a large number of white men, the two factors of (1) a scanty susceptible white population and (2) an absence of opportunities of infection, were done away with. Sir Anthony Home, therefore, caused a quarantine law to be enacted for all vessels coming from infected parts or suspected places. This, in truth, averted the disease, notwithstanding that a recrudescence of yellow fever took place in the ports of the Bonny River, and that, from time to time, cases occurred amongst the crews and passengers of steamers trading between these ports and Cape Coast Castle. Palliative measures were also enacted against the unsanitary state of the town by a permanent sanitary committee.

We have seen, in the last paragraph, the good effects of a strict quarantine. It is hoped it will never be thought unnecessary for yellow fever. The evidence in its favour is overwhelming. Dr. Joseph Jones, of New Orleans, states that experience has shown that yellow fever can be absolutely excluded from localities in which it has prevailed as an epidemic subsequent to importation from other regions, by means of an absolutely strict quarantine. When President of the Board of Health of the State of Louisiana, he claimed that, as a result of the quarantine and sanitary operations during 1880, 1881, 1882, and 1883, yellow fever could be excluded completely from the entire valley of the Mississippi—where it was not indigenous—by a rigid and effective quarantine, embracing not merely detention and inspection, but thorough ventilation and fumigation or destruction of infected cargo. Hænisch, again, demands quarantine for any ship that has had communication with an infected port or ship, even if no case of the disease had occurred on the ship in question on a voyage of several weeks' duration, for the poison may be conveyed in the cargo, and retain its power of acting on susceptible individuals. Finally, Dr. Billings (who, however, uses the word "quarantine" in the sense of "medical inspection") points out that it is more effectual in yellow fever than in any other disease, inasmuch as the latter is cut short by cold weather. Hence, the later the season the disease gains a foothold in a place, the less its effect; and therefore, even if not completely successful, it will prevent its entrance in the vast majority of cases, and will, at any rate, thus tend to delay its importation into any given place.

Jones.

Hænisch.

Billings.

The proof of the action of quarantine is afforded by the results which ensue when quarantine has been absent. Now, the s.s. *Annie Marie* was not placed in quarantine, and the s.s. *Hecla* evaded it. The epidemics at St. Nazaire in France, and at Swansea in England, were the result.

Special Prophylaxis.—But since the Ashanti war we have an additional and powerful preventive measure. As in other diseases, so in yellow fever, various drugs have been proposed as prophylactics. Quinine? Cummins recommended quinine, but it has proved useless. Mercury? Walker, of Jamaica, has commended mercury, but one would hardly give mercury to a campaigning force. Passing by these measures we now come to the results of the researches of Dr. Domingos Freire. Inoculation. Taking up the subject from the point we left it, Freire next tried to elicit benefit from his discoveries. Dr. Freire. He at first attacked the micro-organisms by a method of his own—"anti-microbism"—consisting in the culture of organisms antagonistic to those of yellow fever, and injuring and impeding the action of the cryptococcus xanthogenieus. He first experimented on guinea-pigs, vaccinating them with a culture of these organisms, and found they resisted the inoculation. Subsequently he and M. Rebourgeon determined that the parasite secreted a ptomaine, acting as a virulent poison. By a series of cultivations, this virulence is attenuated, and then the cultivation-liquid, when inoculated, is a prophylactic against yellow fever.

Thus by this principle, after a series of cultivations, the virulence of the virus is attenuated, and a prophylactic fluid against yellow fever is formed. Luckily for humanity, Dr. Domingos Freire lived in a land free from the fanaticism of pseudo-humanitarians. His experiments having attracted the attention of the Emperor of Brazil, that monarch caused an institution to be organized for the purpose of public inoculation as a prophylactic against yellow fever. Dr. Freire then vaccinated 500 individuals, and not a single case appeared amongst them. Amongst them were 150 porters and labourers employed in the port, loading and unloading vessels, and therefore specially exposed to the infection of the disease; these remained exempt, though surrounded by fellow-workers who were struck down by it. The captains and all the crews of three English vessels had been vaccinated, and every man escaped infection. The later results were equally satisfactory. From December 22, 1884, up to March 22, 1885, or a period of three months, 1109 persons of different nationalities, whose ages ranged from one month to sixty years, have been inoculated in the deltoid region. Not one single case was severely attacked, and the very few who had suffered from the fever had it in the mildest form possible. In many cases the process was performed in houses where, a few hours before, deaths had taken place from yellow fever. Again, the results for December 1885, and January and February 1886, are as follows:—In 3051 subjects inoculated in Janeiro, there were no deaths, whereas in the same localities and houses 278 unprotected individuals died of the disease. Lastly, Dr. Isastier found, in Rio Janeiro, the mortality to be 1.6 per cent. amongst those inoculated, but 13.7 per cent. amongst those not inoculated.

Girard. Dr. Freire's plan of preventive treatment has since been followed by Dr. Girard, who began by first inoculating himself, and passed successfully through a mild attack of yellow fever.

Dr. Carmona of Mexico, finally, by the authority of Government, inoculates young soldiers. Experiments have been made on prisoners with their own consent. All those thus inoculated have exhibited symptoms of mild yellow fever, but have quickly recovered. Carmona's method is apparently different to Freire's, but he claims prophylaxis for a period of four or five years. It is to be tested also in the Sonora State and on the west coast of Mexico. Carmona.

There can be no doubt that Domingos Freire has conferred an immeasurable benefit on the white races compelled to sojourn in the endemic regions of yellow fever. Meanwhile, should yellow fever break out amongst any English force campaigning in any endemic or appropriated home of yellow fever, the men should be "vaccinated." We presume that vaccination would be ordered in the case of a severe epidemic of small-pox under similar circumstances. Hence, let such be the rule for yellow fever. Nay, more, such "vaccination" is advisable in any case for an army campaigning in any country in the yellow-fever zone.

Treatment of an Epidemic.—Should an epidemic attack the camp, notwithstanding our precautions, or through lack of the necessary precautions, we have already indicated some of the rules for prevention of, or for limiting the spread of, the disease, such as changing the camp, "dislocating the troops," moving away from the shore or plain to any available height, &c. Billings points out that, even when once the disease has gained a foothold, much may be done to limit its spread or to stamp it out. The practical difficulty in preventing the spread of yellow fever when it is once introduced, depends chiefly on the difficulties of isolation of the early cases, and this, in turn, depends chiefly on the difficulty in diagnosis. To overcome these difficulties, the first case must be diagnosed; if diagnosed, we apprehend there should be no difficulty in limiting the spread. Hence, isolate at once all suspicious cases. And to aid in diagnosis, and thus in prevention, I have given in the appendix to this chapter an excellent scheme drawn up for this purpose by Dr. Bemiss of New Orleans. Having isolated the cases, the next thing is dislocation of the men and depopulation of the camping-ground, combined with disinfection of everything connected with the sick.

This recognition of the first case is of prime importance, as it has been universally found that an epidemic generally gives some warning, by solitary cases becoming attacked; whilst more can be done in the way of prophylaxis by isolation, disinfection, and striking camp, than in other diseases. The tendency of the disease to form small foci of diffusion rather than a universal focus, is also in our favour (Hirsch). Above all, let the men be moved a good distance from the shops of the town, should such exist at the spot of debarkation, and thus prevent them from indulging in excess.

And to eliminate the element of fatigue, all fatigue duties should be performed, should the circumstances permit, by black

followers. Employ black labour instead of white. Finally, attend to the conservancy.

Hospital measures.

In camp, the treatment of the sick, in the preventive aspect, is to be conducted on the same lines as those laid down for enteric fever. The alvine discharges, vomit and urine, are to be treated with chloride of lime or corrosive sublimate, as previously inculcated. Clothing, bedding, and tents, are also to be subjected to the disinfecting processes already mentioned, whilst the hospital attendants, &c., must observe the prescribed precautions. In doubtful cases, the men must remain isolated for observation.

Hospital ships.

But, if possible, all sick should be treated in a hospital ship. A special and additional hospital ship should be provided for the treatment of such sick. Such a ship must, of course, be well disinfected afterwards, by fumigation with nitrous acid, which has been found especially efficient in yellow fever; by washing the woodwork, &c., all over with chloride of lime; pouring chloride of lime into the bilge water, and then pumping it out, &c. The period during which the fumigation should last should be at least forty-eight hours. Such are the lines on which to work. Yellow fever, enteric fever, and cholera require very similar treatment as regards prophylaxis; indeed, at the late Cholera Conference at Rome, on the motion of Dr. Sternberg, it was determined to apply to yellow fever the measures thought requisite against cholera.

Ships generally.

A few final words as regards ships anchored off yellow-fever coasts. They should avoid anchoring close in, especially in a small harbour. And, secondly, following Aitken's recommendation, care must be taken to keep their coal covered up. The deaths at St. Thomas from yellow fever before it became a coaling station for the Royal Mail steamers, as compared with the deaths after, are as 4 : 64. Of course there may be no real connection, but, till this is proved, this precaution had best be followed.

APPENDIX.—DIAGNOSIS OF YELLOW FEVER FOR SANITARY PURPOSES.

By Dr. Bemiss.

A. For sanitary purposes, the following groups of symptoms shall be considered to indicate yellow fever:—

Group 1. A person after (*a*) a sudden attack has (*b*) a fever of one paroxysm, attended with (*c*) marked congestion and blood stasis of capillaries of surface of body, conjunctivæ and gums, with (*d*) a history of probable exposure to infection, and (*e*) no history of a previous attack of yellow fever.

Group 2. A person after (*a*) a sudden attack has (*b*) a fever of one paroxysm, followed by (*c*) unusual prostration, (*d*) albuminous urine, (*e*) yellowness of conjunctivæ and skin, and (*f*) having no previous history of yellow fever.

Group 3. A person has (*a*) a fever of one paroxysm, (*b*) followed by albuminuria, (*c*) black vomit, or (*d*) suppression of urine, and

(*e*) general hæmorrhagic tendency, under (*f*) circumstances where exposure to infection is a possibility.

B. Suspicious cases of yellow fever for sanitary purposes :—

The following six symptoms, associated with a fever of one paroxysm in a patient apparently exposed to infection, and who has never had yellow fever, are to be held to justify *suspicion* of yellow fever.

1. *Sudden attack*, with either violent pain in head or back, infection of eyes or face, or marked superficial capillary congestion.
2. *Want of correlation* between the pulse and temperature.
3. *Albuminuria.*
4. *Black vomit.*
5. *General hæmorrhagic tendency.*
6. *Yellowness of skin.*

CHAPTER XV.

CHOLERA.

In the prevention of cholera in military campaigns, the great fact to bear in mind is, that cholera is propagated by human intercourse. Without human intercourse there can be no epidemic of cholera. The various ways in which human intercourse acts will be portrayed later on, but, *in limine*, I would urge that the factor of human intercourse in the propagation of the disease towers above all factors. It is true this view was recently discouraged in India, but, inasmuch as the saving of human life is the first office of the military surgeon, I promulgate this doctrine with all the force I can. It may seem strange that it is necessary at this period to offer any argument in favour of this self-evident fact, but, inasmuch as the theory that human intercourse has nothing to do with the propagation of cholera, has been advocated both by the advising authority in medical matters at the India Office, and by the late chief sanitary authority in India, I must, before considering the matter in its relation to campaigns, examine the validity of this new development in pathology. Before doing so, it may be well to quote the opinions of an officer of the highest rank as to the spirit in which such inquiry is to be carried on. Dr. Cuningham, in paragraph 19 of his Sanitary Report for 1879, thus writes: "The problem to be solved requires patient investigation, and a calm judgment which shall not be swayed by any preconceived ideas or deterred by the fear of adverse criticism. The cholera controversy has unfortunately excited much animosity and bitterness between those who differ in opinion. The doctrine of human intercourse is for the time the popular doctrine both with the medical profession and with the public, and neither facts nor arguments which are at variance with this view find much favour. All this is deeply to be regretted. If this doctrine is true, it can afford to stand the fullest criticism and the most thorough investigation." Unfortunately, either the spirit of these words was ignored, or it was judged that "the fullest criticism, and the most thorough investigation," would, by irreparably confuting the doctrine of "climate and other causes" as agents in the causation of cholera, cause the downfall of the doctrine advocated by the Government of India and by the India Office; for we find that the same officer in 1878, in the orders on the Berar Sanitary Report, distinctly discourages all accumulation of evidence in favour of the doctrine of propagation by human intercourse; he states, indeed, that "The chapter on Cholera is too

much occupied with the statements and opinions of civil surgeons on the importation doctrine. Little or no practical good can be expected from such inquiries, and it is therefore of great importance that the time of the medical and other officers should not be spent on them. If it were demonstrated that cholera is spread by human intercourse, nothing could be done to prevent such intercourse." Few, I fancy, will be inclined to assent to this expression of opinion.

Before proceeding to the subject as especially relating to campaigns, I shall first show briefly some of the evidence on which the fact that cholera is propagated by human intercourse depends, and next I shall examine the opposite theory as it has been developed by Dr. Cuningham, Sir Joseph Fayrer, and Sir Guyer Hunter. Finally, the theory of Dr. Bryden will be adverted on.

Evidence of Propagation by Human Intercourse.—First, then, I will adduce some evidence that cholera is in reality propagated by human intercourse. This, in truth, is writ so largely throughout the history of cholera that, at the outset, we are embarrassed by its very richness. But in order to help those who maintain the contrary, I will leave out of consideration all the epidemics that have occurred in Europe, for it is needless to say that the opinions of all the authorities who have studied and experienced the disease on the Continent of Europe, are decided on the fact that the disease is propagated by human intercourse. In fact, so decided is this view that we must suppose, in order to reconcile it with the opposite view, that the disease that has appeared in Europe has not been cholera at all, but some other malady. In no other way is it possible to explain that the great savants of the Continent of Europe have held views so dogmatically stamped as erroneous by the few climatic theorists of the East. Let us take, therefore, a few instances from India. In Central India, up to 1865, there used to be yearly pilgrimages to Mahadeo's Cave. But year after year the gatherings were broken up in wide disorder. The germs of cholera were brought thither by the pilgrims, and, on their dispersal, were carried far and wide over the country, as the multitude fled away affrighted. Everywhere their tracks were marked by unburied corpses. Whole villages were sometimes swept off. At length, Government was aroused, and the pilgrimages stopped in 1865. Since this date the epidemics of cholera have ceased.

Pilgrimage to Mahadeo's Cave.

Dr. Cayley has minutely described the cholera in connection with the pilgrimage to Juggernath. In Cuttack and Orissa, cholera shows itself year after year regularly over a defined area, invading the same villages and bazaars, leaving the greater part of the district untouched. The usual course of the disease is intimately connected with the pilgrimages. In Orissa it occurs every year from January to August, sticking to the pilgrim route and adjoining country, and is always worst at the period that the pilgrims are passing in the greatest numbers to and from the shrine of Juggernath. These pilgrimages are not confined to one or two seasons, but, in fact, occur almost monthly; at the

Pilgrimage to Juggernath.

ordinary occasions, however, few people come from a distance. Now, during the first seven months of the year there are four chief festivals—one in March (the second in importance), one in April, one in June, and one, the most important of all, in July. The pilgrims from the north come down by Calcutta, and thence through Midnapore and Balasore, and, as shown by Dr. Cayley, bring cholera with them. In 1873 there was a large epidemic. During September to December 1872, there was very little or almost no cholera. In 1873 it appeared distinctly in Cuttack in January, increasing in February and March, and rapidly increasing in June and July, again diminishing in August, by the middle of which month the pilgrims had cleared out. The district attacked was chiefly the pilgrim route. In the eight months, January to August 1873, there were 2008 deaths from cholera recorded. Of these 1515 occurred in the four thannahs through which the pilgrim route passes; 255 in Olabhur, whither the pilgrims in large numbers came from Calcutta by steamer; thus leaving only 238 for the remaining four thannahs. The returns of previous years again show the same conditions; the thannahs along the main road are, for many months, continually and severely affected, the other parts of the district but slightly.

Now, in these pilgrimages a striking fact came out concerning the respective values of sanitation and isolation. Up to 1867, Cuttack suffered much from cholera. The town contained 50,000 inhabitants, and is dirty, ill-drained, and innocent of sanitary measures generally. But since 1867 the pilgrims have been forbidden to pass through the town, although its sanitary condition remained the same. They are made to cross the river by a ferry below the town, and then their route lies along the east side of it close to three villages, in which, since 1867, cholera is constantly present, although Cuttack is now free. Hunter, in his history of Orissa, writes: "Cuttack, the capital, suffered so regularly and so severely from the passage of the pilgrim army, that the doctors, having tried everything else, at last determined to shut the devotees entirely out of the town. The result upon the public health has been marvellous. A sanitary cordon is now established, and Cuttack is now free from the annual calamity to which it was previously subject. On the other hand, a great contrast to the town of Cuttack is presented by the village of Chowdar, four miles off, on the opposite side of the river. All the pilgrims pass through here and halt. Chowdar is always a focus of cholera during the pilgrim season from January to July." From a consideration of this epidemic, and of the individual facts of infection in definite cases that are related in the paper, Dr. Cayley concludes that the disease is spread by human agency, by people, food, clothes, or merchandise. He also holds that it is carried in no other way, and that when any epidemic is split up into its component parts, it will be found that each person has had the disease conveyed to him directly in some tangible cholera-infected substance, and not through any general influence pervading the air or soil.

Again, in 1886, the annual fair in the town of Pushkur, six miles to the north-west of Ajmere, was held. About 200,000 visitors attended it. The houses are built on the borders of a sacred lake. Owing to the scanty rainfall the water in this holy tank was very low. However, the pilgrims bathed in and drank of the water. Cholera broke out, and was conveyed to Ajmere, and extended thence to Nasirabad, Beawar, Kishenghur; and the surrounding States, as the pilgrims suddenly dispersed, took it in all the directions of their dispersion. Pushkur.

In the Thirteenth Annual Report of the Sanitary Commissioners of the N.W.P. and Oudh for 1884, from Dr. Thompson's account it is clearly shown that the cholera prevailing in Banda district was brought by pilgrims returning from the Allahabad Mela. Again, in 1882, Surgeon-General Furnell, the Sanitary Commissioner for Madras, forwarded his report for the past year, during which cholera was rife in parts of Southern India. There had been a fair at Tirupati, and Dr. Furnell clearly showed how all the districts which had suffered were in direct communication by rail with that place, whilst those not thus connected, had been free from the scourge. In the cholera epidemic of 1885 in Nepaul, Dr. Gimlette shows how it spread along the lines of human intercourse, and how the 12,000 Sepoys, despatched to their homes on furlough, carried the disease to different quarters. Allahabad Mela. Tirupati. Nepaul.

In 1885 cholera was present during the latter part of March and during April and May at Rindli, a large transport depot of the commissariat, and situate, as the crow flies, some sixteen miles from Nari Gorge, the railway depot of the Sind Pishin Railway, and by rail from the same place, about twenty-three miles. No cases of cholera had occurred on the railway since the previous December, when it was prevalent to a slight extent amongst the coolie gangs thereon employed. The following are the facts concerning the outbreak, which raged on this railway during the hot weather of 1885. On or about May 28, five men came from Rindli for work on the railway. Two of these men were attacked. The following day four cases occurred in other gangs working near them. Within three days cholera had spread in a virulent form amongst the men in both directions. A panic occurred, and the men fled in all directions, up and down the line, carrying their sick with them as far as possible, and then leaving them to die. Many of those who reached Sibi took the passage by train to Sukkur and Mooltan, and other places; several were attacked and died in the train. Cholera appeared in all the places to which the coolies went, in some slightly, in others severely: among the latter at Sukkur and Karachi, among the former at Mooltan, where some men of the Manchester Regiment were infected, and died. In the other direction, that is northwards towards Quetta, the disease spread steadily and in a regular manner, attacking the coolies at each station in turn, until it reached Kach on June 28. Hurnai Pass.

But of all examples of the factor of human intercourse, none can excel that given by the great fair at Hurdwar in 1867. With regard Hurdwar, 1867.

to the investigation of cholera, or any other epidemic, my own opinion coincides with that of the vast majority of investigators, that the etiology of any disease is best arrived at from a consideration of single observation of individual examples, and their comparison with one another, rather than of the large epidemics as a whole. Surgeon-Major Lyons has well remarked that "the investigation of cases on a grand and extended scale has invariably resulted in some fanciful theory, christened with a sonorous name, and enunciated with ingenious phraseology of impalpable meaning." Dr. Cayley, of the Indian Medical Service, again observes that it is only by a close examination of limited outbreaks that we shall eventually arrive at the true etiology of cholera. "To obtain accurate results in disease, as in any other natural phenomenon, we must first study minute details, and then build up our theories from them. But the opposite school vividly describe "cholera waves" and "epidemic influences" which are surrounded with a halo of transcendental mysticism, which puts them out of the reach of practical inquiry." However, I will now take the example of the extended outbreak of 1867 as an example of the etiology of cholera. The whole history of this epidemic was most carefully gone into by the Sanitary Commissioners with the Government of India in 1867. And inasmuch as the reasoning employed was admirable, and the conclusions derived of especial interest in the matter of prevention, I shall quote largely from his account. Now, in 1867 the great twelfth-year festival at Hurdwar had come round. Just before the conclusion of the gathering cholera arose, and with the dispersion of the pilgrims a vast epidemic spread over India. The Sanitary Commissioner, in his history of the epidemic, thus writes:—First, in considering the causes of the epidemic, he decides that it was not due to filth and bad sanitation, for the camp was kept far better than, and in marked contrast to, all preceding fairs. Secondly, it was not due to atmospheric phenomena. For there was nothing to show that there was any variation of temperature, or of air-pressure, or of rainfall different to preceding years. Thirdly, was it due to importation? There was cholera in the Terai early in 1867. The superintendent of the district writes, "the pilgrims took it to Hurdwar, and from Hurdwar they brought it back and spread it on all sides. Numerous deaths occurred amongst the pilgrims proceeding to Hurdwar prior to the outbreak."

In the Bhurtpore district, again, cholera was present on April 6. The Maharajah of Bhurtpore visited Hurdwar with a large retinue just at the time when the cholera began to disseminate. The Sanitary Commissioner thus concludes in paragraph 40, that neither filth nor atmospheric causes were to blame. Hence, "if not generated at the fair it must have been brought there. This idea is quite consistent with facts; it is quite consistent with the analogy of other diseases, such as small-pox, regarding the propagation of which we have more precise information. Even had it been impossible to discover the probable source of importation, the arguments would not have

become invalid; but there is the direct testimony of the superintendent of Terai that pilgrims going to Hurdwar from his district had the disease amongst them, and died on the way. It is sufficient to state that the disease, as it broke out at Hurdwar, appears to have been introduced by pilgrims from some infected district." Now, the night before the great bathing day (April 12), a heavy storm flooded the camp; the sewage arrangements favoured the washing of the sewage itself into the Ganges. On the day succeeding the storm the pilgrims bathed in the river, each pilgrim drinking of the water. The bathing-place was a space 650 feet long, by 30 feet wide, shut off from the rest of the river by rails. Into this narrow enclosure pilgrims from all parts of the encampment crowded, bathed, and drank of the water. The water thus drunk was foul and contaminated by whatever was washed from the bodies or clothes of the pilgrims. Cholera broke out in an epidemic form on the day after. I now quote again the remarks of the Sanitary Commissioner.

Para. 300. "*The Effect of the Dispersion of the Pilgrims in Spreading Cholera.*—On this question the facts have been narrated with great care; every statement of every importance has been given, for the evidence has been considered not with the object of supporting any preconceived theory, on the mode of propagation of the disease, but with the sole view of endeavouring to ascertain the truth. Did the pilgrims, as they returned to their homes, carry cholera with them, and thereby occasion the outbreak which subsequently followed in the various districts through which they traversed or to which they belonged?"

Para. 301. "On the first part of the question there can be no difference of opinion. That cholera went with the pilgrims from Hurdwar, and accompanied them to a greater or less distance in every direction, is a fact which admits of no dispute. Suffice it to say, that the pilgrims bore the disease with them to a distance varying from 50 to 300 miles in almost every point of the compass."

Para. 302. "This fact in itself may be regarded as evidence of communicability of the disease. That the pilgrims imbibed the poison at Hurdwar in large quantities cannot be doubted, but it is not probable that the disease should remain latent so very long as to appear among some of them only when they had reached places so far distant as the Upper Provinces of the Punjab. Judging from all that is known of the disease, it appears much more probable that these and others who were seized weeks after they had left Hurdwar were infected by pilgrims in whose company they had travelled, than that the germs of the disease had remained all that time undeveloped within their system."

Paras. 303, 304. "The results of the details regarding the advent of the cholera-stricken pilgrims, and the subsequent appearance of the disease amongst the general population of the districts who had been previously free from it altogether, may be thus summarized: Excepting Goorgaon, in which the history of the first case is doubtful, no cholera appeared in any of

these fifty-one stations or districts until ample time had elapsed for the pilgrims to reappear, or for others to enter from the infected places. There was no simultaneous outbreak of the disease over a large area; but the general evidence is not merely negative, for, excepting Goorgaon, there was no cholera in any of the fifty-one places named until the pilgrims actually had returned, and even in Goorgaon the epidemic prevalence dates from their return."

Para. 305. "But even more remarkable is the evidence that in most cases the first cases in the district were pilgrims who had been to Hurdwar. In thirty-five out of the fifty-one districts the first persons attacked were pilgrims, and after they had been seized the disease appeared and spread amongst the residents."

Para. 306. "In addition to the facts are the decided opinions of numerous medical officers and civil officers by whom the facts were observed. Thirty-two medical officers, many of them men of great experience, who were indefatigable in carrying out the arrangements for the care of the devotees, and most careful in ascertaining the facts connected with the appearance of the disease within the limits of their own charges, are decidedly of opinion that the cholera was imported by pilgrims. In other districts the medical officers have been unable to satisfy themselves that the epidemic was due to importation; but it is a very noteworthy fact that in no case has any positive evidence been advanced to show that such a cause was improbable, much less that it was impossible."

Para. 307. "There are only two ways in which these facts can be satisfactorily disposed of. Either they must be set aside as untrustworthy, or they must be accepted as making out a very strong case in favour of the opinion that cholera is spread by human intercourse. It is quite impossible that the whole story of the returning pilgrims carrying cholera with them from Hurdwar to Rawal Pindi, with the dates of its appearance in the successive districts through which they passed, can have been invented. The facts cannot be set aside. It cannot be regarded as a mere coincidence that in thirty-five districts of Upper India, covering an area larger than that of Great Britain, the epidemic should have gradually appeared in one place after another immediately after the return of a body of pilgrims stricken with the disease."

Para. 308. "If not by the pilgrims, how was the disease spread? It could not have been carried by the wind in all directions at one and the same time, nor is it probable that the force of the wind should have exactly kept pace with the pilgrims. There are, no doubt, difficulties to be explained under any theory which attempts to account for the facts."

Para. 309. "*Analogy of other Diseases.*—But it is to be remarked that similar difficulties exist in regard to the spread of diseases the communicative nature of which is undisputed. Can it be explained why small-pox prevails in some years and not in others? It is a singular fact that all epidemic diseases of which

we have any accurate knowledge, are communicable, and however fitful and inexplicable the cases may be, it may be fairly assumed that every new case is usually, if not always, the progeny of a parent of like kind, although the parentage often, and indeed generally, cannot be traced. The seed of a plant affords a not inapt analogy to what appears to be the most rational view of the germ of epidemic disease. In order to germinate and bear fruit it must fall and be received into a suitable soil. It must be planted at the proper season, and enjoy the advantages of climate and circumstances which are best adapted to its growth. Similar conditions appear to be necessary for the propagation of epidemics. With little doubt the germ of epidemic cholera appears to reside in the evacuation of a person suffering from the disease."

Para. 311. "But whatever theoretical differences of opinion may exist as to the propagation of cholera, the fact of the great epidemic of 1867, and its spread over Northern India, teach no doubtful lesson, and it is this—that human intercourse plays a very great part in the diffusion of the disease, and that returning pilgrims in particular are very dangerous arrivals."

Such, then, is the line of reasoning that most completely justifies and establishes the factor of human intercourse in the propagation of the disease. The chief points insisted on are as follow:—

1. The disease spread to every point of the compass.

2. The outbreak was not a simultaneous outbreak over a large area.

3. No cholera appeared in any place until the arrival thereat of infected pilgrims.

4. In most places the first cases were among pilgrims, subsequently amongst the residents of the places attacked.

5. Out of the fifty-one districts attacked, the medical officers were of opinion that it was due to importation in thirty-two cases, but in none of the other cases was such a mode of origin improbable, much less impossible.

6. The conclusion arrived at—viz., that the return of pilgrims is very dangerous, inasmuch as they play a very great part in the diffusion of the disease, and that the poison lies in their evacuations—that it is not due to bad sanitation or to atmospheric causes.

In concluding the account of the epidemic it may be well to quote the opinions of the Sanitary Commissioner for prevention. They are as follow:—

Para. 311. "How is the return of the pilgrims to be regulated, and what measures can be adopted as far as practical to diminish the danger? In my letter to the Government of India in the Mil. Dept. No. 312 d, May 29, 1867, an opinion was expressed that quarantine should be established. Regarding the matter merely in a sanitary light that opinion remains unaltered; but a careful consideration of the many important points involved leads to the conclusion that any general attempt to enforce this measure is undesirable."

Para. 215. "But though a general quarantine is certainly undesirable and indeed impossible, such a measure should certainly be adopted as regards the entrance of any persons into military cantonments who are likely to convey the disease; and when the disease is abroad, communication should, as far as possible, be cut off between the station and the neighbouring city. Even here the system cannot be carried out in a perfect way; but it would appear that the larger the body of infected people, the greater is the danger which they bring with them, and if the result be only to diminish the centre of infection, and not to prevent its introduction altogether, much good may be anticipated."

Para. 316. "And although any general legislative enactment insisting on quarantine is open to great objections, municipalities might be permitted to carry out such a measure when any unusual danger threatened. The general tendency which has been borne to the benefits of such an isolation of suspected persons cannot be altogether ignored."

Para. 320. "A perfect quarantine, even as regards the convict population, is almost impossible. Practical results are of much greater value than mere theoretical opinions, and the introduction of even such an imperfect quarantine as has been practicable in the gaols of Upper India, has been attended with excellent results."

Such, then, is the history of one of the most striking examples of the propagation of cholera by human intercourse. As Dr. Parkes truly declared, it was an example on a gigantic scale of cholera water poisoning.

Hurdwar, 1879.

In 1879 another twelfth-year festival came round. This, as I shall show further on, had especial relations to our force in Afghanistan. But, in the meantime, I draw attention to it for the purpose of stating that this epidemic was held by the Sanitary Commissioner with the Government of India in 1879, to be wholly independent of human intercourse. Now, it may be argued that the initial circumstances of place and mode of dispersion were different in 1867 and 1879; otherwise, how can such diametrically opposite views of the two similar occurrences be explained? But this argument cannot be brought forward; for the Sanitary Commissioner in 1879 expressly declared that the attendant circumstances of infection and dispersion were "nearly exactly the same as in 1867." The Sanitary Commissioner of 1879 now held that the cholera was due to "climate and other conditions affecting certain localities." And this leads me to examine some of the arguments that he brings forward to controvert the opinion that cholera is not propagated by human intercourse.

Influence of railways.

Railways are said not to have hastened the diffusion of cholera. This is utterly opposed to the facts connected with the Allahabad outbreak in 1882, as shown in the report of Dr. Rice, the civil surgeon. Since the network of railways has spread over India, the country has had cholera where it had not appeared before. Even the example narrated by the Sanitary Commissioner himself contradicts this dictum. The following table is quoted from paragraph 58 of Sanitary Report for 1872:—

Station.	Years.	Strength.	Admissions for Cholera.						
			Jan. to June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Mian Mir . .	1856	1576	...	...	435	65	1	...	...
" . .	1861	1700	...	...	661	64	...	...	...
" . .	1869	974	...	...	...	...	...	...	...
. .	1872	1358	...	1	179	5	...	...	...

The Sanitary Commissioner thus comments: "A glance at these cases will show that (in 1869, 1872) they occur no earlier than they did before (in 1856 and 1861). At Mian Mir it is worthy of notice that in the epidemic of 1861 the first case among the Europeans was on August 2. It 1872 it was on July 31, a difference of two days." But in commenting on the statement, Surgeon-General De Renzy, the Sanitary Commissioner of the Punjab, draws attention to the remarkable fact that the details of the epidemic of 1867, which *began in May*, and attained its maximum in July, *is omitted from consideration*, "although the influence of railway communication in diffusing it was most marked." Also, the same officer shows how no mention of the fact that in 1872 cholera appeared in *May*, and was most virulent in *June*, in the lunatic asylum at Lahore, about five miles only distant from Mian Mir. De Renzy also showed how the frequency of cholera in the North-West Provinces has increased since the introduction of railways. The dates of the epidemics show unmistakably how the latter increased in frequency after the introduction of railways. Thus, the dates are as follows: 1805, 1813, 1827, 1845, 1856, 1861, 1862, 1865, 1867, 1869, 1872, 1875, 1876, 1879, 1881. Again, with regard to the influence of railways in the diffusion of cholera, Surgeon-General Furnell, of Madras, has shown how, in a certain epidemic in that province, the disease only appeared in the directions traversed by railways, omitting those to which there were no railways. As I am, for the present, purposely excluding cholera as it appears in Europe, I do not enlarge on the many histories of the influence of railways in increasing the diffusion of cholera there, such, as for instance, as Koch has shown, the greater frequency of cholera in such districts as Penschat since the opening of the railway lines.

Relation of nurses to the disease.

Secondly, there is the very old stock argument which apparently never wears out with age, but rather ripens and mellows like wine. It is this: that the hypothesis concerning human intercourse cannot be true, inasmuch as hospital attendants are never attacked with greater frequency than other classes of the community. Putting aside the fact that, when occasion favours, they *are* more attacked, the whole question is begged by this line of argument. For by it human intercourse is interpreted as contagion, and it is thus stated that cholera is not propagated by human intercourse, because, as a rule, nurses are not seized with comparative greater frequency. This is a typical example of the method of argument employed by the climatic theorists. But

human intercourse may signify contagion in some diseases, and may signify nothing of the kind in others. The same line of argument might be applied to enteric fever. Nurses do not, as a rule, catch enteric fever from enteric-fever patients. Therefore, it might be held, that enteric fever is never spread by human intercourse. In order, however, that this argument may be finally dismissed, it is only necessary to state that cholera, like enteric fever, does not spread, as a rule, by strict contagion, as is the case with small-pox and other exanthemata, but that it spreads by infection, as distinguished from contagion. That is to say, that cholera, like enteric fever and yellow fever, and occasionally dysentery, spreads by the sick infecting the healthy by means of the contagium from the sick entering the alimentary canal of the healthy with the food. Of course there are exceptions, such as are found also in the case of enteric fever. For instance, Roth and Lex describe cases spreading from bed to bed. I believe direct contagion scarcely ever occurs. But not only may the discharges infect the food, and so convey the disease, but they may also infect the air, and so convey it. The atmosphere, loaded with the virus evacuated with the dejection, may poison a fresh individual, by such infectious particles being swallowed. Instances that hospital attendants *do* catch the disease will be given further on. Dr. Cuningham, in the Report for 1877, para. 142, lays down the following: "In order to prove that cases of cholera among attendants are due to contagion, it must be shown that the attendants suffered in larger proportion than others." And, again, in para. 65 of the 1872 Report, he states: "The proof of the contagious nature of cholera, or any other disease, is only to be made out by showing that persons who have come in contact with those suffering from this disease, have suffered in a greater proportion than those who have not." Taking these conditions, therefore, it can be easily shown by numerous examples that the dictum that hospital attendants are never attacked with greater frequency than others, is erroneous and contrary to fact. I refer, for example, to the facts under the heading of Precautions to be taken by Hospital Assistants.

The A B C argument.

A third argument that has been employed is the A B C argument. It is stated that granting that A caught the disease from B, and B from C, yet this will not establish the theory of human intercourse; for, in time, we shall get to Z, and then, where can Z have got the disease? But it is manifest that the same argument applies to all the other diseases that are acknowledged to be infectious or contagious, and if such an argument be held valid, all infectious and contagious diseases will be at once eliminated from medicine.

The theory of "one-sided anecdotes" and suppression of adverse facts.

A fourth statement is made which is, I must confess, somewhat startling. The careful investigations of authorities who uphold the theory of human intercourse are characterized as "one-sided anecdotes," and all facts adverse to the view are held to have been suppressed. Considering that the greatest investigators of our time are here implicated, such men, including Parkes, Cornish,

Furnell, De Renzy, Macnamara, George Johnson, Bristowe, Simon, Netten Radcliffe, Liebermeister, Koch, and a host of names of cosmopolitan celebrity, the accusation of "one-sided anecdotes" and of "suppression of adverse facts," bears with itself its own refutation. Was the Report of the Sanitary Commissioner of the Government of India for 1867 issued on a basis of one-sided anecdotes? It is somewhat surprising that the large number of medical officers of 1867 who were then stated by the Sanitary Commissioner of 1867 to have been "men of great experience, and most careful in ascertaining the facts connected with the appearance of the disease within the limits of their own changes," should have been succeeded in 1879 by men apparently endowed with precisely opposite mental characteristics.

Many other points in the line of argument of the Sanitary Commissioner for 1879 might be adverted on. But space forbids. I will now, therefore, finally comment on three remaining facts connected with this part of my subject. First, what is the cause of cholera as submitted in the place of human intercourse. Dr. Cuningham states that cholera is due to "climate and other causes." Of all the statements with which I am acquainted in the history of medicine, this statement carries the easiest refutation. If there is one fact that has been established in the history of cholera, it is this, that the disease has been met with under every known variety of climate. No clearer objection to this theory can be furnished than that given by the Sanitary Commissioner with the Government of India for 1867. This officer writes in para. 31 of the Report on that epidemic as follows:—"Even in England where meteorological observations have been taken on a scale and with a care which have as yet been unknown in India, so far as our knowledge yet goes, nothing appears more hopeless than to establish any connection between epidemic cholera and known states of the atmosphere. Of the several epidemics of the disease which have visited London, the main feature in connection with this important point is the very remarkable contrast which they exhibit. Thus, Mr. Radcliffe, writing of the epidemic of 1866, says, that the visitation of 1832, 1848, and 1854 were coincident with great atmospheric pressure, high temperature (except in 1832), small diurnal range, deficiency of rain, very little wind, and comparative stagnation of atmosphere. In 1866 the atmospheric pressure was remarkably low; the temperature low, night and day, except in September, when the nights were warm, abundance of rain, and the air in almost constant motion." He finally writes, that "there was nothing to show that any such cause acted (in 1867), or that the atmospheric conditions were very different to those of former gatherings in which there had been no outbreak." This theory of a climatic origin has been well designated by Ballot, of Rotterdam, as the "genius epidemicus, or Deus ex machinâ invoked whenever there is any difficulty." Dr. Lauder Brunton and Pye Smith, thus write concerning it: "Some even yet hold that cholera results from a peculiar atmosphere, and other conditions, rather than from a specific poison;

Climatic theory.

Sanitary Commission of 1867.

Ballot.

Brunton. Pye Smith.

but as it may be conveyed from one infected locality to numerous others by a single individual, breaking out where he has stopped, and passing over those places where he has only travelled through, though there may be present identical conditions of sea, air, and water, it is shown conclusively that it cannot be due to these circumstances alone." Again, the Vienna Conference of 1884, in which were assembled representatives of all countries, stated that there were no facts to show that atmospheric causes could bring on cholera alone. On the contrary, it stated that "all facts go to show that in free air the generative principle of cholera rapidly loses its morbific character." Let us now see what ground for this climatic theory there is in more special cases. Taking the disease in the sub-tropics, Malta may be cited as an example of a sub-tropical climate. In reviewing the causation of the epidemic in Malta in 1865, Dr. Leith Adams well observes that from its geographical position as regards Africa and Europe, we might think Malta would be far less subject to epidemic visitation than islands situate in the immediate vicinity of continents. Yet this has not been the case; for there has scarcely been an epidemic in the eastern basin of the Mediterranean, or in the beaten path of commerce, that has not found its way to Malta, whilst many islands not in the path of commerce have escaped. Hence, such skipping disproves the mere meteorological condition known as "epidemic constitution." And as regards the meteorological factor, it was observed that the prevalence of cool north winds did not decrease the sickness, nor did that of the southerly sirocco increase it. And, again, it was found that all the cholera years had been characterized by dryness and high temperature; but that, on the other hand, other non-epidemic years had excelled these in this respect. Dr. Leith Adams next shows that the pilgrims conveyed the disease from Arabia; that the cities in Egypt, not in the homeward tracks of the pilgrims, at first escaped; that the seaports in the Mediterranean that had the closest maritime intercourse with Alexandria were first affected, and that it broke out in Malta after the arrival there of vessels with cholera on board. From the sketch-map, showing the path of cholera, it is clear that the disease radiated from Alexandria to the seaport towns of the Mediterranean *in the exact ratio* of their communication with it, whilst, on the other hand, intermediate countries, seaports, and islands not in direct communication escaped entirely. "These facts are incontrovertible, and whilst they furnish indubitable proof of the communication of cholera by human intercourse, strongly militate against the existence of a 'general epidemic constitution' in the Mediterranean basin."

Vienna Conference, 1884.

Leith Adams.

There is one crushing reply to the upholders of climatic causation, which they have never been able, or even attempted, to answer. One of the most marked features of cholera is its localization. It will seize one side of a street, leaving the other side free; it will seize one out of several barracks; or one line of tents in a given camp. Are we to suppose, contrary to all laws of the diffusion of the atmosphere, and contrary to all common sense, that the "climate" in the parts affected differed from that

Localization of the disease.

in those unaffected? And if not, how will the climatic theorists explain the localization? Thus, take the outbreak that occurred at Aliwah, near Mooltan, in 1876. Dr. Gray, the civil surgeon, shows how it was introduced into Aliwah, probably by a party coming from Sealkote on September 23, cholera being at that time prevalent in Sealkote. He draws attention to the marked limitation of the outbreak to so small an area, and thus sums up: "With regard to the theory that cholera is originated or spread solely by atmospheric agency, it appears to me that the Aliwah outbreak is another proof of its extreme improbability. It almost does violence to our reason. Certainly it seems contrary to all we know of the laws relating to gaseous bodies, to suppose that a cholera-impregnated atmospheric wave can capriciously select one small village like Aliwah, and discharge its deadly contents upon it, while it passes over and leaves unscathed other villages which are in all respects similar and within a few hundred yards of the doomed one." Dr. Cayley, again, with reference to cholera in Orissa, shows that the disease in that locality in no way resembles the course of a wave or great atmospheric current even in exceptional years when it spreads epidemically, as it never attacks every, or nearly every, town or village, and never marches through the country with anything resembling regular progress. Lastly, a crucial instance of the groundlessness of the view is shown by Dr. Simpson, the Medical Officer of Health for Calcutta, in the *Indian Medical Gazette* for September 1887: "If cholera prevalence is to be explained solely by seasonal influence or waves, the behaviour of these waves, as shown in their relation to Calcutta, Howrah, and the suburbs, is somewhat remarkable. Calcutta is practically surrounded by Howrah and the suburbs, yet the same seasonal influences during the past five years have had a most intense effect on Calcutta compared with previous years, whilst, on the town of Howrah and the suburbs, the effect has differed little from usual. Assuming that the meteorological condition favourable to the promotion of cholera prevalence existed, and that for a series of years some peculiar combination of electrical, chemical, astronomical, telluric, cyclonic, and other unknown conditions were present which had been absent previously, it has still to be explained how such a condition pervading the whole city elected for its operation a special locality; why it was less effective in its work of destruction in the south part of the town than in the north; why, even in the north part, some localities remained stationary, and others improved under their peculiar conditions; whilst, on the riparian side generally, districts have been attacked with a virulence equalled only by a few localities scattered here and there over the northern and central portions of the town."

Cases at Aliwah.

Dr. Simpson on cholera at Calcutta.

But certain conditions of the atmosphere have been actually adverted on as aiding cholera or calling it forth: such as the yellow fog in Egypt during the late epidemic there, misty states, still atmosphere, high barometric conditions, and absence of ozone. Exactly similar conditions occur, however, in regions where cholera

Supposed atmospheric influences.

never appears, whilst the disease appears, as often as not, unaccompanied by these conditions. If, as Dr. Cornish, late Surgeon-General of Madras, observes, Dr. Cuningham's theory of atmospheric influences were true, there is no reason why Australia and South Africa should not suffer from cholera as well as India. In regard to these supposed "atmospheric" conditions, there is not a single case on record where cholera has broken out in ships at sea after an absence of a certain number of days from an infected port. The fact that there are no such cases goes to prove that "atmospheric conditions," where there is no terrestrial taint, cannot produce cholera; nay, more, in Dr. Cuningham's latest work summing up his results on retirement from office, there is not a single instance adduced of cholera appearing anywhere in the absence of human intercourse. Indeed, up to 1879, Dr. Cuningham himself had found no grounds for asserting the influence of atmospheric conditions, for, in paragraph 10 of his report for that year, he thus writes: "Another year's experience has thrown no light on the influence of atmospheric phenomena on cholera, and has indicated no peculiar condition of the air which would seem to be associated or connected with outbreaks. On the contrary, the evidence is very conflicting, and the states of the weather, as described in the reports, would appear to have varied greatly." Finally, the late report on the subject for Bengal bears testimony to the same fact. Dr. Lidderdale, the sanitary commissioner for Bengal during 1886, especially inquired into the relation of meteorological phenomena to cholera. There were well-defined outbreaks in Bogra and Faridpore. As the reviewer of this report stated, "sheet after sheet of figures were drawn up, but, as Dr. Lidderdale showed, the result arrived at was *nil*."

Dr. Cornish.

Dr. Cuningham.

Dr. Lidderdale.

The second fact to be annotated on is the relation of human intercourse with cholera as upheld by Dr. Cuningham. What do we find invariably has been the case in all epidemics? We find that cholera never appears anywhere without having been transported from an infected spot; we find it never travels from one locality to another more rapidly than a man can travel; that the march of an epidemic always follows the lines of travel; that, in England and America, it has always attacked first of all seaport towns on the advent thither of an infected person, and has thence proceeded onwards by the lines of traffic; and, finally, that it has never broken out in any isolated country or town without distinct human importation. But all these facts, he holds, are to be explained as "mere coincidences." There is no more truth that man has brought cholera than that the mail-coach brought hoar frost. Certainly, if this line of argument be true, the cholera epidemics of 1867 and 1879 in India would be the greatest example of coincidences on record.

Thirdly and lastly, we have seen how the sanitary commissioner for 1867 differed from the sanitary commissioner of 1879; on every point exactly opposite conclusions are drawn. But, remarkable though this be, it is still more remarkable that the sanitary commissioner for 1867 and the sanitary commissioner for 1879 are one

and the same authority. But so strong is the evidence portrayed for the influence of human intercourse by Dr. Cuningham when sanitary commissioner in 1867, that in his subsequent reports he has never controverted it. It would seem then, that, at all events, the conclusions drawn in 1867 are unanswerable, and, as such, I submit that his former reasoning was true and his latter groundless.

Opinion of Sir Joseph Fayrer.

We next arrive at the opinion of Sir Joseph Fayrer. This authority states "most emphatically that he does not believe in the contagiousness or communicability of Asiatic cholera" (*Lancet*, p. 296, February 16, 1884); that he does not believe that cholera ever has been or ever can be carried from one place to another by means of human beings, or by merchandise travelling in vessels or in any other way. Surely such statements should be supported by cases. I have searched diligently for any accounts of epidemics or attacks observed and reported by Sir Joseph Fayrer on which he has based this opinion; but I cannot find any, although doubtless they exist. But in the debate on Surgeon-General Hunter's report on Cholera in Egypt, Sir Joseph Fayrer stated that he was ignorant of the "iota causans" of cholera. If, therefore, Sir Joseph Fayrer does not know anything concerning the origin of cholera, it is difficult to understand on what grounds the emphatic opinion is given that it is not due to human intercourse, or why he denies this factor, which, though it may not be the "iota causans," yet it is certainly considered to be the "alpha, beta, and gamma" of the disease by the vast majority of observers who have had actual experience of the disease. It must be also remembered that a large portion of Sir Joseph Fayrer's experience in India was derived from Calcutta. It is needless to say that it is far more difficult to trace the origin of disease where it is endemic than where it occurs in separate outbreaks. Still, as we shall see later, even under the former circumstances, if accurate search be made, the true origin can be made out.

Sir Guyer Hunter's views.

With regard to the views of Sir Guyer Hunter on the late cholera epidemic in Egypt, in the first place it is to be noted that this officer went to Egypt with views prejudiced to the communicability of cholera. Having determined in his own mind that cholera was not imported into Egypt in 1882–3, Sir Guyer Hunter, in his report, stated that it may have originated in the unsanitary state of Egypt. But, as Macnamara observed on this point, the unsanitary conditions of that country have never yet been known to give birth to epidemic cholera, nor have such conditions done so in any part of the world. Failing this cause, the epidemic of 1883 might have been a revival of that of 1865. That cholera, be it called by whatever name it may be—as Asiatic cholera, epidemic, sporadic, cholera nostras, or cholerine—had existed in Egypt for some time past, and that the diarrhœa which was so common and deadly, in many instances was but cholera. Sir Guyer Hunter stated that evidence proved that cholera had existed in Egypt in an endemic form since the epidemic of 1865, and probably anterior to this date. Sir Guyer Hunter considered cholera nostras to be identical with epidemic cholera. How the

idea can be raised that epidemic cholera with a mortality often of 50 per cent. can be identical with cholera nostras, which is scarcely ever fatal, I must confess surpasses my understanding. A most crushing review of the report is to be found in the *Practitioner* for March 1884. Sir Guyer Hunter went so far as to assert that examples of cholera were not of unfrequent occurrence in many towns and cities of Europe, not excluding the British Isles. Such a line of argument, it is needless to say, wiil prove anything. As the reviewer in the *Practitioner* remarked, "the report appears to have been prepared under the influence of a very strong antecedent personal bias in favour of the views which it has succeeded in formulating, views which have not been modified by the very imperfect nature of the only evidence which could be procured, or by the total absence of any scientific experiments. Apart from the evidence of Assiout, which may be regarded as tending only to show that Damietta was not the first place attacked, the general body of the evidence contained in the report does not seem to us to be of a character such as should suffice for the formation of an opinion so entirely at variance with the views of other competent observers who have spent long years in carrying out personal inquiries, and who have endeavoured to avoid forming opinions based on hearsay evidence alone." But Macnamara, in a lecture published in the *British Medical Journal* for March 15, 1884—a lecture which should be read by all—most satisfactorily accounted for the epidemic. He pertinently remarks that, if the cholera of 1883 was but a revival of the epidemic of 1865, would not the Sanitary Board at Constantinople have known of the continued existence of the disease in Egypt? "But Asiatic cholera has never yet visited Egypt unless it has first broken out in Turkey, Arabia, or Europe, whence it could be traced back to India. In 1882, for the first time in the history of Egypt, a large body of native troops and camp followers were brought by steamers and landed in that country from India; and in 1883, at its usual season for development, Asiatic cholera appeared among the Egyptian people. It is worthy of note also that, in consequence of the war, the international sanitary arrangements of Egypt and the Red Sea were suspended during the latter half of 1882–3."

Views of Dr. Bryden.

Lastly, I come to the view held by Dr. Bryden. This authority divided India into two great areas—1. *The lower provinces*, in which was the permanent and perennial abode of cholera. Here the disease was generated in the soil. 2. *The upper provinces.* Here cholera is merely a visitor, as it is in Europe. The disease is carried thither by the wind, provided moisture is present. The essentials for an epidemic are (1) the presence of the cholera miasm, (2) a humid atmosphere as the vehicle, (3) the prevailing wind to give direction and limitation to this humid atmosphere. The invasion from the endemic area is, in fact, connected with the monsoon, whilst the difference of prevalence in different years is dependent, in great part, on variations in the monsoon. He regarded the spread of cholera over any area as not due to human intercourse, and, indeed, held

that the disease could not be carried by human intercourse beyond the limits of the area naturally occupied by the cholera germ. This was the rule; but Dr. Bryden admitted that occasionally infection was caused by human intercourse. No one can help regarding with admiration the work done by Dr. Bryden in India, yet we find insuperable difficulties in his theory; for, as Macnamara points out, the people living on the hills of Lower Bengal, and therefore under the influence of the winds blowing over the endemic area of cholera, are yet free from it. Again, how does cholera spread by the monsoon beyond India, when, in fact, it is beyond the influence of the monsoon? Dr. Parkes showed that, beyond India, its spread does not coincide with the wind, but with human intercourse. In 1865, Southampton had the same winds as Portsmouth, and was even more protected by lying up an estuary; yet Southampton was attacked with cholera, whilst Portsmouth and every other seaport over which the first wind passed escaped. And why? The answer is simple. The steamers running from Alexandria and Malta, *where cholera was then present*, touched at Southampton but *not* at Portsmouth. Again, Dr. Cornish showed how, in Madras, an epidemic actually spread far and wide in the teeth of the monsoon in 1869–70. Dr. De Renzy, again, demonstrated, in his sanitary report of the Punjab for 1870, that it is absolutely untenable for that part of India for which it was designed—viz., the North-west Provinces. Again, Macnamara points out that, in the great epidemic of 1818, cholera advanced down the Madras coast and across to Bombay *against* the prevailing wind. Finally, with regard to the monsoon, the latter authority clearly shows its connection as follows:—"The south-west monsoon would appear to be the indirect cause of the dissemination of cholera over the country in that it brings with it moisture—a necessary element for the development of the disease—but more especially because it is before this wind that the large fleets of country boats move up the Ganges, conveying men and goods from the home of endemic cholera to be disseminated over the upper provinces."

I have now criticized the arguments of those who have been chiefly conspicuous in their opposition to the factor of human intercourse. Before finally quitting this part of the subject, one more annotation is necessary. In his last brochure on cholera, Dr. Cuningham, in the preface, claims to set forth "a few of the great facts showing what has been the experience of India in regard to the disease." In the work in question the experience of India is then claimed as showing that human intercourse is never connected with the diffusion of cholera. But is this the experience of India? Let us take the opinions of the senior officers of the Indian medical service who were in India or had left it, at the time these words were penned. Dr. Cornish, Surgeon-General of Madras, declared at the inauguration of the Madras Branch of the British Medical Association, that "he was bound to say there, that all his individual experience, extending over thirty years, would lead him to deal with the epidemic form

Experience of India as regards diffusion of cholera.

Madras. Surgeon-General Cornish.

of cholera, as favoured in its diffusion under certain circumstances, by human intercourse." Surgeon-General M. C. Furnell, his immediate successor in Madras, at the third annual meeting of the same Society, declared that his opinion, after "forty years' experience" of the disease, was that water contaminated with cholera dejecta was the cause of cholera epidemics. Surgeon-General Moore, of the Bombay Presidency, has placed on record, not only his belief in propagation by human intercourse, but even that it can be carried by *flies*. Surgeon-General Townsend, of the Central Provinces and Punjab, was of the opinion that human intercourse acted in the diffusion of the disease. Surgeon-General Payne held the same opinion for Bengal. Surgeon-General De Renzy for the Punjab and Assam. Surgeon-Major Geoffrey Hall, of the North-West Provinces, has declared, in a debate on cholera at the N.W.P. Branch of the British Medical Association, that he has never met a man who agreed with the views set forth by Dr. Cuningham. Surgeon-Major Deakin holds the same opinion. Surgeon-General T. Murray addressed an inquiry to 481 medical officers in India as to the transference of the disease by direct intercourse, 363 answered in the affirmative, 38 in the negative, whilst 85 were undecided. Again, as regards the communication by the intestinal discharges, 442 answered in the affirmative, 5 in the negative, and 34 were undecided; whilst as regards the diffusion by drinking-water, the respective numbers were 414, 16, and 51. Surgeon-General Irvine, of Assam, believed, again, in human intercourse. Many other names might be quoted, but enough have been mentioned. And what does this testimony mean? It means that the testimony of the above various Surgeons-Generals and Sanitary Commissioners, in its totality, is the testimony for the whole of Hindostan, a testimony in most instances gathered from a lifetime spent in the country; and finally, a testimony totally opposed to what has been declared to be "the experience of India" at the time.

Surgeon-General Furnell.

Bombay. Surgeon Moore.

Central Provinces. Surgeon-General Townsend.

Punjab. Assam. Surgeon-General De Renzy. North-West Provinces. Surgeon-Major Hall. Surgeon-Major Deaker. Surgeon-General T. Murray's inquiry.

Assam. Surgeon-General T. Irvine.

So much, then, for the theory of the non-propagation of cholera by human intercourse. It cannot hold water for a moment, and the mind can scarcely conceive a theory more dangerous to life. That this is so is testified by the fact, that since the Army Medical School at Netley has been founded, army surgeons have been consistently warned by the Professors of medicine and hygiene, against it. The names of Parkes, Maclean, and Du Chaumont are, by themselves, a sufficient guarantee that the theory is contrary to all facts. Now, Prof. Maclean, in his lectures, warned his hearers against the theory of Dr. Cuningham; whilst the matter was viewed by the late Dr. Parkes—than whom no more impartial critic ever existed—as "revolution," an opinion confirmed by his successor in the chair of hygiene, Dr. Du Chaumont, who has styled it "nihilism." And as such I leave it, with this final remark. Its author has claimed that, as sanitary commissioner with the Government of India, he has enjoyed paramount opportunities for formulating his theory that cholera is due to "climatic and other conditions affecting certain localities," inasmuch as he has been able to judge of the disease in India as a

Teaching at the Army Medical School.

Parkes, Maclean, Du Chaumont.

whole. He denies that the civil or military surgeon serving in cholera camps, in the plains, is capable of forming a correct judgment from merely local outbreaks. But the greatest living master of geographical pathology, Prof. Hirsch, of Berlin, has enjoyed still greater facilities in this direction; and from a survey of cholera, as it has appeared in *all* countries, he holds it communicable by human intercourse, and sums up thus: "That it is human intercourse which furnishes the media of this communication, is proved on a large scale by the observations on the diffusion of the disease by pilgrimages and military campaigns, both in India and beyond it; whilst there are other conclusive proofs, furnished in innumerable instances from the smaller circles of diffusion." And again, "It has been the same disease on the marshy soil of the Gangetic Valley, the saline steppes of Central Asia, the high table-lands of Armenia and Algiers, the sandy plains of North Germany, the prairies of North America, in great epidemics and in small, in sporadic cases as well as in epidemics; and it has shown itself in respect of its types, to be thus unmodified by the latitude and longitude, and by the climate of the country, district, or place which it has invaded." Professor Hirsch.

I now turn to the great keystone of the prevention of cholera—viz., the salient fact that it is spread by human intercourse. We have seen it is held by the vast majority of authorities in India, whilst in Europe this opinion is practically unanimous. The volumes of the A.M.D. Reports teem with this fact, and the impartial reviews therein of Dr. Parkes, of the various evidence brought forward by the great continental authorities in the epidemics that have affected Europe, afford evidence which cannot be stronger. Now, it is worthy of remark that there is one noteworthy characteristic of all the authorities who insist on this fact. They declare that such a method of communication is an undoubted fact, but their creed is tolerant, they are willing to admit that cholera *may* spread in other ways, although no evidence for such a supposition has as yet been found. And on this side I unquestionably range myself. By acting on the indications given by this hypothesis, I was successful in stopping a development of cholera in my regiment when on service in Afghanistan. Human intercourse the keystone of cholera.

I believe cholera to be a specific disease due to a specific cause, and this cause multiplies in the body of the sick, and is a particulate organism. From transfer of the contagion from the sick to the healthy an epidemic is produced. If no intercourse occur directly or indirectly, between the sick and the healthy, there will be no epidemic. In addition, as with other infective diseases, certain condition of time and place, and individual predisposition, aid in disposing to the disease. Now human intercourse may act in various ways, but the essential fact is, that without human intercourse, cholera cannot be propagated. Some of these methods are illustrated by the opinions of the following authorities:—Tommasi Crudeli holds the disease in Europe is always an importation, due to a morbigenous germ proceeding from a diseased human body, but which will not diffuse itself epidemically, except Tommasi Crudeli.

the soil be favourable for the multiplication of the infectious germ contained in the excretions. Hirsch states that there can be no doubt of the communicability of cholera, and holds that the choleraic patient eliminates a morbid germ, which is at first incapable of reproducing the disease, but becomes so under favourable external conditions. Pettenkofer lays the greatest stress on the influence of the especial locality for the production of an epidemic, but the specific germ "must be transported to the locality through the agency of human traffic." As regards human intercourse, no one can be more explicit. "Cholera must be reckoned amongst the infectious diseases, and there must be a cholera poison which has yet to be found. Transportability by men and animals is undoubted." And again, "human intercourse is a fact which I unhesitatingly accept." Finally, in his last utterances on the subject, he states that "the cholera germ must be brought by human intercourse anew into the locality, in order to develop and cause an epidemic. The facts must lead to a complete rejection of the autocthonous theory." He, however, makes man merely the vehicle, but the place the "foyer." As, however, Dr. Parkes sagely observed, the difference is merely verbal, for *something* is brought to that "foyer." It is manifest that without importation by human intercourse there can be no epidemic. The primary importance of human intercourse over locality is, on the face of it, manifest; for granting that locality is a factor, yet the cholera germ must be brought there in the first instance for the factor of locality to come into action. But when we see how places with the greatest possible variety of soil and other characteristics become the seat of cholera, it is difficult to understand how local influence can be the chief factor. The advice of Dr. Parkes is as sound now as it was on the day on which it was written—viz., that whether human intercourse plays a part or not in cholera *we are bound to act as if it did.*

Hirsch.

Pettenkofer.

Parkes.

The means by which human intercourse acts is indeed by a plurality of ways. These several ways will be indicated presently in the analytical elements for prevention; suffice it now to enumerate the air, the drinking-water, the cooking-water, the solid food, the bedding, the tents, the bodies of the dead. And dominating all these, and giving them the office of vehicles, we have the dejecta of the sick or their effluvia.

Nature of an epidemic.

Granting now that the disease is propagated by human intercourse, will this fact alone account for the devastating epidemics? Are we here obliged to invoke that aged "Deus ex machinâ," the "genius epidemicus," to our aid? Granting that in a severe epidemic of cholera there is some additional influence at work to that of human intercourse, yet this is no reason why we should at once say human intercourse has nothing to do with epidemics of cholera. No epidemic of cholera can start without a first case any more than an epidemic of small-pox can. In Prescott's *History of Mexico* we read how "Maxixca, the old lord of Tlascala, had fallen a victim to that terrible epidemic the small-pox, which was now sweeping over the land like fire over the prairies,

smiting down prince and peasant. It was imported into the country by a negro slave. The poor natives were ignorant of the best mode of treating the loathsome disorder." No one, we would presume, would deny that small-pox here was contagious, and we see that the natives were ignorant of vaccination and everything, hence the spread. And such will be the spread with cholera under climatic theories. Who can doubt but that the late epidemic in Spain was due first to the disease having been imported, which has been proved, and, secondly, to the filthy local conditions, and filthy human intercourse? But with regard to this question of epidemicity, we ourselves believe that human intercourse, by infecting the water supply, will account for all the great epidemics. To illustrate this, we need merely refer to the enteric-fever epidemic, before commented on, at Plymouth, U.S. Here over 1000 people, in a not large town, were infected by the water supply in one month. It has been well observed that a single case of cholera may, if the local conditions of the water supply co-operate, exert a terribly infective power on considerable masses of the population. One case will impart to enormous volumes of water the power of propagating the disease. And yet there have been sanitarians who deny all influence in the water supply in propagating the disease. I firmly, however, believe with Surgeons-General De Renzy and Furnell, that if once the water-supply is hindered from being poisoned by the dejections of the sick, epidemics of cholera will cease; and I agree with Lebert's statement that, "to deny all influence to the drinking-water is a scepticism utterly unjustifiable."

Reasons for local immunity.

Human intercourse, then, acting with locality and individual susceptibility, constitutes the key to the etiology of cholera. Now certain parts of the world, and certain parts of India, have ever been free from cholera. If we can only find out the reason of this, surely we can apply it to the seat of a campaign and thus keep out cholera. A short consideration of this question is necessary therefore.

Can "climate" or "atmospheric force," *et hoc genus omne*, supply us with the reason? If they can, they will not, however, give us any indications for prevention. But they are utterly powerless to offer any explanation. We have before referred to the question as regards the localization of cholera in any given camp or station. But as regards large tracts or countries, we gain also no information. The hillmen of Bengal are free from cholera, though living under the same atmospherical conditions as the people all around, and living, moreover, under every condition of insanitation. But as long as they remain in their native hills they do not get cholera, although the disease is raging around them. However, directly they come down to the plains, or have any communication with the plain-men, they not only suffer from cholera, but they do so in an inordinate degree. At once, then, we have the key to the immunity of the lower hills of Bengal. There is the greatest mutual aversion between these races, amounting to what Mr. Macnamara describes "to the most

stringent laws of quarantine." The very name of quarantine is as a nightmare to certain minds, but, *nevertheless, here we have an absolute quarantine, and as a consequence cholera is not imported.* The important bearing of these facts we shall show later on, when referring to our campaigns on the north-east frontier. But we see here, again, the same writing on the wall: guard against human intercourse, and the camps will be free from cholera.

Besides human intercourse, the factors of *locality* and *predisposition* also explain the immunity of certain places. The local conditions procuring immunity and their application to camping grounds will be portrayed anon; meanwhile, as in other infectious and contagious diseases, importation is not necessarily followed by cholera. Substitute cholera for typhoid fever in the following quotation:—"No matter how well a field is manured, wheat will not grow unless wheat be sown. But no one would think for that reason of denying the importance of the quality of the ground and of the manure for the culture of wheat; if we sow on rocks we sow in vain. In the same way, besides the presence of the typhoid poison, many other conditions are necessary to produce typhoid fever. The germs of the poison which come from the sick must find a favourable soil for their reception and growth. Finally, every one who receives the typhoid poison is not necessarily attacked with the disease. For the individual also, besides the reception of the poison, other circumstances are necessary to develop the disease" (Liebermeister). We have quoted this sentence to show how *locality* and *predisposition* will explain the immunity of certain places. No matter how well a locality is manured by absence of sanitation, cholera will not grow unless cholera be sown; moreover, the soil on which the germ alights must be favourable, but when all this is said, there is nothing more peculiar in cholera in these respects than in any other communicable disease.

In concluding the survey of the factor of human intercourse, it may be thought that I have been engaged on a work of supererogation. But it is not so. Imbued with the teachings of Parkes and Johnson, and impressed with the caution of the former that we are bound to act on the hypothesis that cholera is spread by human intercourse, even though this had not been proved over and over again by the collected experience of Asia, Europe, and America, I arrived in India to find that cholera was instituted to have nothing to do with human intercourse, and to be told that even if it were demonstrated that it were so, nothing could be done to prevent human intercourse. When, therefore, the disease attacked the camps seriatim in the Kurram Valley in 1879, I had to decide whether to abide by the teachings of Parkes and Johnson, or to adopt the diametrically opposite views of those in authority in India. After anxious consideration, I determined not to desert the old faith for the new, and by this resolve I was enabled to keep my regiment free from cholera after it had actually been therein introduced.

Summary. By working on the lines of Parkes, we believe that the prophecy

of his successor in the Chair of Hygiene at Netley will become true—viz.: "That it is not chimerical to believe that a time will come when cholera will be merely an historical curiosity."

As far as military medicine is concerned we must recognize, *ab initio*, that cholera spreads by human intercourse. And as regards human intercourse, it matters not whether man acts as a simple vehicle for the specific poison, or as the focus, as we hold, in which the poison is reproduced. In the first alternative man must carry first the poison to the locality in which it is destined to multiply; without such transport it is manifest the given locality will then be free from the disease. Thus we have a two-fold object to carry out. To prevent the transport of the specific poison to our camps, and to render our camps so hygienic that, even if it be carried there, it cannot germinate.

The germ theory.

The poison, as we have said, is *specific*. Is it now necessary for us, as military sanitarians, to consider at all the germ theory? Certainly, if the germ theory of cholera be only a pathological figment, or if true, only a bare truth leading to no practical results, I should not be justified in wasting time on it in a practical work like the present. But it is not thus. The discovery of Prof. Koch has rent the veil that formerly obscured many things from us in the pathology of cholera, and in doing so, has given us fruitful indications in its prophylaxis. It is, therefore, necessary to enter on the subject so far as to show how Koch has added to our means of prevention.

In his address before the Imperial German Board of Health at Berlin in 1884, Koch truly observed, that without a sound basis of the knowledge of the essential nature of cholera, all therapeutic and prophylactic measures were in vain. We can imagine well with what generous enthusiasm the late Prof. Parkes would have welcomed the recent discovery. For, be it remembered, Parkes evidently saw that the explanation of the vital phenomena of cholera must be sought for in the germ theory. So aptly does his criticism on Hallier's fungus apply in its reasoning to Koch's bacillus, that it will be well to quote his reasoning here, substituting the "bacillus" for the "fungus."

Dr. Parkes would then hold that the bacillus is universally present in cholera stools; that it answers to the conditions of a foreign origin for cholera, connected with human intercourse, and coming to Europe *ab externo*. A living germ—such as the bacillus—again is the only agent that answers to the conditions of transmission by air and drinking-water, and of being wonderfully affected by ventilation. The singular discrepancies in which the cholera cause is affected by the nature of the ground, rainfall, and temperature, cannot be explained by a material, but only by a living, agent. The conditions which affect the duration of the course of cholera are precisely the same as those which affect the life and growth of living germs. Finally, the life and growth of a germ indigenous to the tropics, demanding special conditions, propagated almost wholly by human intercourse, and destroyed in immense amount by adverse agencies, gives again an intel-

ligible idea of its manifestations. Such would still be the reasoning of Parkes, as it is the reasoning of his pupils.

The proof that the bacillus in question has a causal relation has been given by Koch and by Watson Cheyne. The following then may be taken to represent the causal relation of the germ and the disease:—

1. The bacillus in question is a distinct micro-organism specific to cholera; its specificity is shown not alone by its morphology, but by its behaviour under culture. The bacilli of Deneke, Flügge, Finkler, and Timothy Lewis, have been thus differentiated by Koch and Cheyne.

2. The bacillus in question is always present in Asiatic cholera, and nowhere else, and is the only form constantly thus present.

3. It is present, moreover, in greatest numbers in acute and uncomplicated cases, and in the parts most affected.

4. It is never present in other diseases or in healthy persons; nor has it been found outside the body when there was no cholera in the neighbourhood.

5. Lastly, as regards experimentation on animals: Koch introduced the cholera bacillus into the stomach of guinea-pigs, injecting also into the peritoneum a narcotic dose of opium. He induced thus, in thirty out of thirty-five guinea-pigs operated on, fatal cholera. Watson Cheyne's experiments were indicative of the same result. Prof. Klein indeed attributed the deaths to be due to septicæmia; on the other hand, in his experiments, Cheyne was satisfied that the deaths were not so due. Again, Rietsch and Nicati inoculated a number of guinea-pigs with cholera microbes obtained from the intestines of patients dying from the disease, and the animals all died after symptoms of diarrhœa and cramp. But granting that cholera has not indeed been thus produced, this is no argument against the comma-bacillus, for many infectious human diseases cannot be reproduced in animals under similar circumstances.

Thus, the bacillus of Koch *is constantly present in Asiatic cholera*, and, *secondly*, *has never been found anywhere else than in Asiatic cholera*. A striking example of the truth of this assertion was furnished by Drs. Milles and Macleod in an investigation carried on during the epidemic of cholera in the summer of 1885 at Shanghai. Twenty-seven cases of Asiatic cholera, seven cases of diarrhœa, two of dysentery, and four specimens of healthy saliva were experimented on. Koch's bacillus was found in twenty-five of the twenty-seven cases of cholera; in two cases it was not found, but here the stools were not collected during the stage of collapse, and were not at all characteristic, being fœtid and fæcal. Comma-shaped bacilli were also found in the diarrhœa and dysentery cases, and in the saliva, but the cultivation-test failed in every instance, thus proving them to be different in the most important vital characteristics of growth under the same conditions. Hence, if the bacilli be found in any dejecta, these dejecta must have come from a patient suffering from Asiatic cholera; and hence, if Koch had determined nothing else, "one achievement

may be fairly credited to him—namely, he has supplied us with a means of diagnosing Asiatic cholera in the early stage." What this means in the matter of prevention of an epidemic needs no comment. Watson Cheyne again with regard to Klein's remarks that "by acclimatization he can, *after a time*, cultivate the salivary bacillus in the same material as that employed for the cholera bacillus," shows that as Klein can only do so *after a time*, this in no way invalidates the value of the organism as indicating cholera, *in the first instance*.

Thus, then, we have indicated to us a safe means of diagnosis of the first suspicious case. But more: the study of the life-history of the bacillus gives us indications of the greatest importance for preventive treatment. How these preventive measures are to be carried out will appear in the appropriate place. Meanwhile, the special features in the life-history of the organism in this respect are the following:—

i. The organism cannot exist apart from moisture, but is actually killed by drying.

ii. The organism is destroyed by the normal acid of the gastric secretion, as it is by an acid gelatine or meat infusion cultivating medium.

iii. The existence of putrefaction arrests the growth of the cholera organism. (This does not mean, however, that we should encourage putrefaction; as we shall presently see the indication is quite different.)

iv. Its culture suggests certain indications, as we shall see, regarding (1) locality and (2) food.

v. Koch holds that the organism can multiply both inside and outside the human body, thus uniting the views of both parties upholding human intercourse—the "localists," and the "contagionists" of Pettenkofer.

With regard to the normal acid of the gastric secretion destroying the organism in question, it has been held that, if this is so, the bacillus cannot be the cause of cholera, inasmuch as it cannot pass unscathed through the acid contents of the stomach. One cannot maintain that in all persons attacked by cholera the stomach was so deranged at the time that its secretion was not acid. Dr. Matthew Hay, Professor of Medical Jurisprudence, Aberdeen, has easily refuted this objection. By experiments, he has found in cats that the reaction of the stomach was invariably alkaline when the viscus is empty, or when only containing water. Hence, after fasting, or where meals are not taken at the usual intervals, there will be opportunities enough for the bacilli to pass unharmed into the intestine.

Lastly, the generic relation of the comma bacilli of Koch to cholera was strikingly shown *in corpore vili* at Berlin. A physician attending Koch's course of bacterial investigation in cholera was seized with a true attack of cholerine, with "frequent watery, colourless stools, unquenchable thirst, and urinary secretion reduced to a minimum, and cramps." Examination of the evacuation showed the bacilli. This case occurred at a place, and at a

time, when every other source of cholera infection than the manipulation of cholera bacilli was absolutely excluded.

The mere fact that at certain times and places cholera is in a state of abeyance is at once explained on the germ etiology, for such abeyance is characteristic of the whole world of flowers and animals. Meanwhile, it is a remarkable fact that Macnamara, twenty years ago in Calcutta, found that the properties of the contagium of cholera were extremely like those characterizing Koch's organism. Thus, amongst other properties, Macnamara found that the contagium was destroyed by acids, and that the infectious matter was rapidly destroyed by drying. There can then, I think, be but little doubt that at length the specific organism of cholera has been discovered. And, in concluding this relation of the germ etiology to military medicine, I cannot forbear quoting Pettenkofer on the parasitical nature of cholera, especially as he does not admit the agency of Koch's organism. In a paper read before the Munich Medical Society in 1880, Pettenkofer declared that the scientific and practical solution of this most important question was only conceivable in connection with the parasitical theory. It must be either a fungus or the product of the same. He had always considered the cause of cholera as parasitical, something organized, and of such tenacity that it had escaped our observation, like the fermentation germs in the atmosphere. He then showed how parallel would cholera be with alcoholic fermentation, if we were to suppose the alcoholic fermentation germs limited as regards their endemic home to India, and transportable by human intercourse only. The juice of the grape in Europe would cause no drunkenness until intercourse with India had brought the alcoholic fermentation germ to the grape district, when epidemics of drunkenness would arise.

In concluding our general remarks on the factor of human intercourse, I now challenge any of its opponents to name one single instance of any campaign in which cholera has appeared in the scene of action either unconnected by a direct chain of continuous propagation from a focus from without, or in a locality in which there was an utter absence of cholera in the neighbourhood.

Cholera in Campaigns.—I now come to the practical fulfilment of the principles we have advocated. Let us first take a short retrospect into bygone tropical and sub-tropical campaigns, and see how we have fared with regard to cholera.

Now, at once, a fact comes out with reference to these campaigns. It is this. Only those campaigns which have been carried on near the great home of cholera, or in which a large moving infected body of human beings have passed through the theatre of action, have been affected with cholera. This is a most remarkable circumstance. Since the year 1860, and up to 1885, we have been at war in tropical or sub-tropical regions. Year after year, with the exception of the years 1861, 1862, 1866, 1869, and 1881, this has been the case, and cholera has only played a part in the China, Looshai, Duffla, Malay, and Afghan wars. Out of

nineteen campaigns in tropical and sub-tropical climates, in only five has cholera appeared. Yet they were all in hot "climates." If "climate" caused the attacks in these campaigns, surely "climate" is but a fickle goddess. But what do we find has been the case with these campaigns? Why this. That in Looshai and Duffla the affected part of the expedition passed through cholera-stricken districts; that in Afghanistan, the stream of individuals returning from the great Hurdwar festival infected with cholera came into intercourse with our troops; and that in Malay and China, the expedition started from a port where cholera is always prevalent. Nay more. In another expedition—that to Egypt in 1882—there was no cholera in Egypt amongst our troops; but afterwards, cholera having been imported into Egypt (as we most firmly believe it was, and consider it proved to have been), our troops contracted the disease, although living under precisely the same "climate" there as before. Comment is needless.

In the China war of 1860 cholera hovered around the camps, but it never gained a permanent lodgment. The camps were immediately moved on the appearance of any case, and thus the element of human intercourse counteracted. China, 1860.

In the left column in Looshai, 1871–2, serious outbreaks occurred. Their origin and course affords one of the most instructive chapters in the whole history of cholera. In the left column the outbreak occurred in connection with the Nepaulese coolie corps employed with that column. The whole of these coolies were hillmen of Bhootan and Nepaul, and, as already noticed, such men when they descend into the plains of Bengal are most liable to cholera. These men, moreover, were shockingly filthy in their habits. The following, then, was the course of events here:—On October 26, 1871, they had an eleven days' march to Goureepore. No sickness occurred during this march. They remained camped at Goureepore for seven days, that is, till November 12. This camp is only three miles from Dhubri. At this time cholera was present in the Dhubri district. Moreover, at Dhubri was a large tank used for bathing and ablution by the depot coolies. Natives invariably rinse their mouth with the water they bathe in. The water-supply of Dhubri has been described by Surgeon-General De Renzy (independently of the Looshai outbreak) in the following terms: "The water-supply of the depot at Dhubri, a place some way up the Brahmaputra river, was extremely bad.* In the emigration season it was a mere stagnant backwater of the Brahmaputra, on the bank of which the cholera dead were buried, and, I may add, often disinterred by wild animals. I have seen vultures eating human remains, and dropping fragments of them into the stagnant pool in which the coolies bathed and, at the same time, took their drinking water." In this pleasant neighbourhood, then, the coolies remained for seven days, having been previously to their arrival here quite healthy. They then, on November 12, em- Looshai, 1871–2. Left column.

* The very period of the year we are now dealing with.

barked in a steamer and flats to proceed up the river. On these rivers of Eastern Bengal, when in October and November the country is drying up, cholera is always present, and at this time especially cases were noted at Dacca as having occurred between November 7 and 15. The transports called at Goalundo on the 14th, and at Dacca on the 16th.

On board the transports the number of men was in excess of the alleged capacity of the vessels. Dr. Wise, in his report, especially mentions the crowded state of the decks. Their food was good except in one respect, the ghee had turned rancid, and caused much gastric derangement amongst the coolies. Thus we have so far an unsanitary race on a crowded transport suffering from stomachal derangement, and passing along and camping on a river in Eastern Bengal, for every evening the coolies landed to cook their meal. Dr. Buckle, the principal medical officer, had directed that inquiry should always be made concerning cholera in the villages on the banks, so that their neighbourhood might be avoided, but the report expressly states "that there is nothing to show whether Dr. Buckle's precaution was ever carried out." We have also seen them encamped for seven days in a cholera-infected neighbourhood and close by a hotbed of the disease. What resulted? Two days after leaving the infected neighbourhood of Dhubri, a case of cholera occurred amongst them (on the 14th). Another case occurred on the 16th, and on the 17th the disease broke out severely, cases occurring every day up to the arrival of the transports on the 22nd at Chuttuk. The mortality from the 14th to the 22nd was fifty-seven. At Chuttuk the epidemic was reported to head-quarters at Cachar, whilst measures were at once taken on the lines of common-sense to deal with the disease. These measures were based on the factor of human intercourse, and so successful were they *that in twenty-four hours the outbreak was suppressed.* They will be referred to later. The principal medical officer, Dr. Buckle, in his comment on this outbreak in the left column, held rightly that it arose from the coolies being landed during their voyage, and then coming into communication with the infected villages of the infected district, whilst the severity of the outbreak was due to the overcrowding and especial predisposition of the hillmen. So much, then, for this epidemic in the left column coolies. An equally instructive outbreak occurred in the right wing of the Assam Light Infantry. Here the head-quarter wing of the regiment reached, on March 6, Tipaimookh, in unusually good health, in course of evacuation. The health of this regiment had been especially good, inasmuch as the men were more acclimatized to the country. On March 7 they halted at Tipaimookh. On the day following they embarked on the river Barak for Cachar, and on this day two cases of cholera occurred in the regiment. Cases from this date constantly occurred until Cachar was reached on the 13th. Dr. White, the medical officer in charge, clearly proved that the outbreak was due to the men drinking the river water. This river-water was

everywhere polluted by the boatmen of the transports between Tipaimookh and Mynadhur. They were 1000 in number, chiefly from the delta of Bengal. As early as December cases had occurred amongst them, and they increased in number, and were increasing when the regiment met them on the return march. Their filthy habits accounted fully for the river pollution. Finally, shortly before, a large number of coolies sick from cholera had passed down the river.

The disease was arrested first by an order to the men not to use the river-water, but that of the "khalls" running into it, whilst the march out was hurried on as fast as possible, so as to get away from the boatmen as soon as possible.

In the right column an epidemic occurred, which is also most conclusive as regards the etiology of cholera. The history of this report has been most fully described by Surgeon-Major R. T. Lyons, from whose account the following summary is extracted :—"The area of operations comprised a narrow, elongated tract, the whole extent of which was under observation. Cholera was unknown among the Kookies till 1860–1, when the Government sent their first punitive expedition against them from Chittagong. Several cases occurred at that time, but since then, until the present expedition (in 1872), it had not appeared. That the tribes did not regard it as indigenous, is manifest from the name they gave it—viz., "the white Bengali death." The authentic evidence derived from Captain Lewin, Deputy Commissioner of the Chittagong hill tracts, who had resided there for many years, showed the disease was absolutely unknown in these regions prior to the entrance of the force, "and thereby our investigation was cleared from the difficulty of ascertaining whether there was an etiological connection between the disease and the local or endemic conditions of the country, as has been asserted elsewhere by high authorities. It is unintelligible that a telluric, miasmatic, pandemic, endemic, or other occult force could be in abeyance for ten years and inoperative on many thousands of human beings scattered through every part of these jungly regions. The force of any of these mysterious influences might be as reasonably supposed to have been dormant during the period occupied by the expedition as it undoubtedly had been in the preceding year." The investigation was facilitated by the fact that the disease did not appear till some time after the van of the expedition had penetrated into the jungles, and hence the first manifestation came under the notice of responsible persons and are known with precision. Right column.

The strength of the force was a little over 6000, and the numbers were distributed along the entire line from Chittagong to the remotest part reached. From Chittagong on the Bay of Bengal, the troops proceeded by river to Kasalong. Six to eight weeks before the arrival of the troops at Kasalong, a large body of police and several hundred coolies cleared a track in the jungle, made huts and godowns, and did other work. During this preliminary period there was no cholera.

The first appearance of cholera at Kasalong dates from the arrival of the troops. It may be well here to describe the camps on the scene of operation. From Chittagong, on the Bay of Bengal, the troops went by river to Kasalong, an intervening station being at Rungamattea. From Kasalong to Lower Burkhut there were two ways for progression, one by river, the other by a jungle track. From Lower Burkhut to Upper Burkhut the track lay only through the jungle. From Upper Burkhut to Demagiri, the commissariat stores went by river, the remaining part of the force by the jungle road. No cholera broke out beyond Demagiri. The camp at Oothman Chuttea lay between the Upper Burkhut and Demagiri.

The following is the history of the various outbreaks of cholera. The 2nd Ghoorkhas and the company of Sappers embarked in the same vessel from Calcutta in good health about the end of October, and proceeded to Chittagong. In the Sundeep Channel two cases of cholera occurred, one in the person of a bugler of the Sappers, and the other in that of a bheesty belonging to the 2nd Ghoorkhas. Both were left behind at Chittagong. On November 8th a Sepoy of the 2nd Ghoorkhas was seized when proceeding up the river, and died at Kasalong on the 9th. This regiment arrived at Kasalong on the 9th, and there another case occurred, and was transferred to the General Hospital on the advance of the regiment on the 12th. On the 13th, the Sapper company arrived at Kasalong; at this place a convalescent case of cholera was transferred to the General Hospital. On the 16th a Ghoorkha Sepoy of the guard left at Kasalong was seized; on the 19th a servant of a native officer of the Ghoorkhas at Kasalong, and on the 21st, a man of the coolie corps.

No fresh cases occurred till one on the 25th instant in the 27th P.I. This regiment arrived on the 26th, having had a case of extremely severe choleraic diarrhœa at sea, the second day after leaving Calcutta. Again a pause occurred, till the arrival of the 4th Ghoorkhas, when on the day following their arrival—December 1st—a case occurred. At a later date the artillery arrived. This corps remained free throughout the operations.

An interval occurred until the arrival of a body of Nepalese coolies in the middle of December. Two corps of coolies were raised at Darjeeling and Gowalpore for service in the Cachar and Chittagong columns. The disease appeared in both corps after they had passed Goalundo. Cholera was present at various places *en route*, and choleraic diarrhœa at Goalundo. On December 7th the flat carrying the Chittagong coolies reached Chittagong, with five cases requiring admission, and several convalescent, the disease having broken out the day after leaving Goalundo. Fifteen had died before reaching Chittagong. At Chittagong all the sick were separated, and the healthy then sent on in two batches. Within five days twenty-one other cases occurred at Chittagong.

The first batch of coolies left Chittagong on December 9th for Rungamuttea, arriving there on the evening of the same day. Seven cases occurred on this short trip, of which one died; the

remaining six were left at Rungamattea. The batch were put into several boats, so as to allow greater space, and proceeded on to Kasalong. No case occurred on the day of their arrival or on the following day. On the following morning the coolies and their clothes were well washed with water and carbolic acid, and then landed to hut themselves one mile from the station. On December 13th two more cases occurred amongst them, on the 16th another case, and on the 19th two cases. After this date no more were infected. Their encampment was changed from time to time, the sheds abandoned were burnt, and fresh spots lower down the river away from the villages selected.

During this period—on the 16th—a case occurred in the 4th Goorkhas, and on the 19th one in the 4th and one in the 2nd Ghoorkhas.

On December 24 the Commissariat Baboo, who had come up with the coolies from Calcutta, and had victualled them, was seized. All his stores of atta, &c., were burnt, and his tent disinfected and ventilated. No case was ever found to have occurred at this time amongst the natives of the country, thus showing that the disease was not endemic, but that it must have been imported.

The second batch of coolies left Chittagong on the 12th, and on the 13th reached Rungamuttea. Seven cases occurred. No fresh cases occurred after the 13th. Both batches remained in their camp for two weeks from date of last case, before proceeding on to the front.

Whilst the above events were progressing, a very serious outbreak occurred in the detachment of 4th Ghoorkhas beyond Burkhut. A day after the arrival of the Nepalese coolies at Kasalong, the half Battery Mountain Artillery was ordered to the front, and marched on December 14th, accompanied by the telegraph coolies, who had come up by land from Kasalong. The latter reached Upper Burkhut on December 14th. On December 16th the battery and coolies proceeded on the march to Demagiri with a detachment of the 4th Ghoorkhas from Upper Burkhut. This detachment was divided into two parties, one in charge of the telegraph party, the other advancing to Demagiri. On December 17th, cholera seized a mahout, then three of the telegraph men, then the Ghoorkha escort. The outbreak was very virulent but short; out of twenty-two cases sixteen deaths occurred in eight days. The outbreak was thus caused. The telegraph coolies came up by land from Chittagong and Rungamuttea to Kasalong. They had no intercourse at Kasalong with the Nepalese coolies; but at Rungamuttea they were encamped at less than a quarter of a mile from the first batch of Nepalese coolies, and were believed to have thus contracted the disease. Dr. Chesnaye had no doubt that the cholera was introduced into the detachment of the 4th Ghoorkhas, by the telegraph servants, who had just come up from Chittagong and joined the party at Burkhut. There had been no case of cholera in his regiment except that occurring at Kasalong on December 1st, seventeen days before the

men of the detachment were attacked on the road between Burkhut and Demagiri.

On January 16th, another small outbreak of eight cases with six deaths occurred, lasting three days at Kasalong. This, again, offers an instance of what is alleged by the climatic theorists never to happen. For the cholera came *down* stream on this occasion. Investigation showed it was due to the telegraph coolies, who had accompanied the 4th Ghoorkhas in December. The last case occurred amongst the latter on December 23rd. Then followed quarantine for ten days, after which they were allowed to enter Demagiri. On January 11th, eleven of these coolies started from Demagiri downwards, and carried the infection to Kasalong. This change in the direction of the cholera was consistent with the progress of the expedition at this date. Up to December the troops and coolies were constantly coming up from below to take part in the operations. Subsequently, large parties came back from the upper stations to be shipped to Calcutta. On January 27th the last case was reported

During all this time no case occurred in any of the villages. Drs. Allen and Meadows never saw or heard of any. But subsequently three men from a village visited Kasalong, one of whom was infected and died ; the other two returned, and then 180 men of the village died. This village was free from it until it had the disease introduced by men infected at Kasalong.

In commenting on the outbreak, Dr. Lyons shows how there was an absence of cholera in the district for ten years previous to the expedition. Now the limitation to a few individuals only, shows that the various occult influences to which its origin has been elsewhere attributed were non-existent here, for a universally diffused poison would not attack only a few individuals out of 6000, or severely afflict some, leaving others untouched. It is incomprehensible that an occult influence should attack a detachment of Ghoorkhas on the road between Burkhut and Demagiri in December, and leave unscattered 5000 men marching on the same road in November, and again on the same road in March. No natural force shows a partiality in its operation on human beings; but here we have the extraordinary fact that of all the Europeans, gunners, and police in the force, not one man was attacked; that of an entire regiment, the 27th P.I., only one was attacked : and that of all the servants and syces, &c., only two were attacked. Dr. Lyons concludes his able report by showing how the arguments for contagion applied by the late Dr. Murchison bore out the fact that the cholera here thus spread. Thus,

1. *When an infectious disease commences in a ship, station, or camp, it often spreads with great rapidity.* This is shown by the coolies on board the *Jibooma.* Between December 2nd, when the outbreak began, up to December 19th, there were fifty cases; in the detachment, 4th Ghoorkhas, in eight days there were twenty-two cases; at Kasalong there were eight cases in fifty-seven hours.

2. *The prevalence of the disease in camps, stations, or ships, is in direct proportion to the degree of intercourse between the sick and healthy.* The proofs of this occurred throughout the epidemic, whilst, where intercourse was prohibited by caste, orders, or nationality, the same was shown. In the two sections of the detachment marching to Demagiri, the Hindoos suffered greatly, whilst the Musalmans escaped to a man.

3. *Persons living in a locality where the disease was unknown, were infected on visiting persons at a distance.* This has been shown by the example of the men from Rutton Pooea's village.

4. *The disease is imported by infected persons into localities previously free from it.* The theatre of operations had been free from cholera for ten years until it was brought up to Kasalong by infected persons of the force. The road between Burkhut and Demagiri was free from it as also the latter station itself, until the disease was taken up by the infected telegraph coolies. Rutton Pooea's village likewise was free from it until the disease was carried thither by persons infected at Kasalong. The patients in the general hospital at Kasalong were free from it until it was imported by a party of twenty-four invalids transferred from Lower Burkhut on January 22nd.

5. *The contagious nature is indicated by the success attending measures taken to prevent its importation, and especially the early removal or separation of the infected.* The General issued definite orders to separate and stop infected parties. Cessation of entire traffic along the line of communication was enforced for ten days from the last case of cholera after the serious outbreak in the detachment of the 4th Ghoorkhas. Thus, the epidemic among the Nepalese coolies was almost exclusively confined to them. The disease in the detachment, 4th Ghoorkhas, was thus limited, and prevented from extending to the troops at Demagiri and the posts beyond. No one was permitted to enter Ratton Pooea's village in the immediate neighbourhood of the scene of the outbreak in the 4th Ghoorkhas, and thus this village at the time escaped, until subsequent communication brought infection.

In concluding this survey of the outbreak in the right column, I would state that the above account is based on actual facts. No theory is involved. The climatic theorists have never answered this able account of Dr. Lyons, nor is it easy to see how they can. What answer can they bring forward to the demonstration that in this instance cholera spread by human intercourse? The only possible answer is that the facts above portrayed did not occur.

Having in view these occurrences in Looshai, the medical Duffla, 1874 authorities took especial precautions with respect to cholera in the Duffla expedition, guarding against overcrowding of the coolies on the transport, and enforcing cleanliness and liberal disinfection. The result was brilliant. The Duffla hills are in the same part of the world as the Looshai country. The force disembarked on November 17th, 1874, and marched up to the

Duffla country, passing through endemic districts of cholera. But owing to the measures employed, cholera may be said not to have affected the force. For there seems to have been but *one* case, which occurred on December 3rd, amongst the coolies attached to the survey party, which party was on in advance. The survey camp at once moved off the line of advance to fresh ground, and remained isolated till it was certain no more cases were amongst them.

Malay, 1875-6. In connection with the Malay expedition, cholera broke out on the transport *Malda*, proceeding from Calcutta to the scene of action. There were, however, only three cases in all. The cholera patients were put into the boats on the lee side of the ship; their clothing and bedding thrown overboard; the troop deck dry scrubbed, and spread over with a disinfectant powder; and carbolic acid thrown into the latrines and scuppers. Here then the disease was stayed by isolation and disinfection, the two grand principles of treatment.

We now proceed with the analytical division of the subject as regards prevention.

Selection of Men.—Under this heading may be noticed the various points connected with personal predisposition, and from this consideration some indication may be gathered in selection, especially as regards camp followers. Different individuals experience very different results during an epidemic; some are severely attacked; others not at all. But the same occurs in all infectious diseases, and is not peculiar to cholera, and certainly is no argument that cholera is not infectious. All we know is that here as elsewhere individual predisposition is a necessary factor, and if we can exclude this predisposed element, we shall gain thereby. Now in certain cases we can. As regards British troops, regiments newly landed in India should also, as regards cholera, not be sent on a campaign. Bryden has shown the risk pertaining to such troops if cholera break out, in the following table:—

	Lucknow, 1864.	Lucknow, 1869.	Benares, 1865.	Meerut, 1869.
Mortality of new troops from cholera . .	27	42	9	105
Do. old troops, do. . .	11	11	Nil	6

In the next place it would appear that the negro race is especially prone to cholera. Christie, from his experience on the east coast of Africa, shows the mortality was 6.5 per cent. of the population among the Hindoo coolies; 10 per cent. among the Arabs; and 25 per cent. among the negroes. Again, in the Mauritius and Réunion, the African race furnished by far the largest sickness and mortality in 1819 and 1854. Walther shows the following proportion in the 1865 epidemic at Guadaloupe; 2.7 of the Chinese population; 3.26 Hindoo coolies; 4.31 of the

whites; 6.32 of the mulattoes; and 9.44 of the negroes. Lastly, in the United States Army, in 1886, the mortality per 1000 among the white troops was 77.0; and among the black 135. From this then we learn, that, *cæteris paribus*, camp followers should not be selected from the negroes, should it ever be a question of enlisting such labour in any region.

A second indication has also been taught us by Macnamara and the Looshai campaign. Coolie corps should not be formed for expeditions in the north-east frontier of Bengal out of the hillmen, as coolie corps could always be organized from the plain men, and would not be so predisposed to the disease. We are bound to consider these points, and not as it were to carry a combustible tender with us.

Other points in idiosyncrasy may be mentioned. In India, Bryden has shown that Europeans suffer thirteen times as much as natives. He has also shown that though the Sepoys of the plains have a comparative immunity, yet that the Sepoys of the hills suffer nearly as much as the Europeans, if not quite. The Ghoorkhas are well known to have an especial predisposition to cholera. Hence as regards cholera, Ghoorkha regiments would incur more risk. Dr. Bryden in 1861 showed the proneness of Ghoorkhas to cholera, as compared with the natives of the plains. Thus, per 1000 of strength the ratio of mortality was Europeans, 78.82; Ghoorkhas, 35.94; Hindustanis, 5.18. It would be well to restrict all such campaigns to native troops as much as possible, and as has wisely been practised hitherto. Although the proneness of the European to take the disease is far greater than that of the native, yet Hirsch has shown from a table "compiled from several years observations," that the mortality related to the sickness is actually greater among the Sepoys. This certainly has been the case in some epidemics; but was not so in the epidemic in the Kurram Valley in 1879. Nor does it appear so from the statistics of Bryden, which show a mortality of 53.63 per cent. for European troops, and of 4.11 per cent. of native.

As regards the question of *age*, the years of military service have in the matter of cholera an advantage, and stand in contrast in this matter to enteric fever. The figures given by Roth and Lex show that at this age there is a much less than average disposition to the disease.

Finally, can we take advantage of any immunity gained from residence in India, or from previous attacks of the disease? That a certain immunity is acquired from a residence in the plains of India as compared with residence in a hill station, is shown by the following instance:—The right wing of a British regiment had been for three years in a hill station; the left wing in the plains; they then came together, and subsequently the whole regiment was attacked with cholera; the right wing suffered a mortality to the extent of 18.8 per cent., whilst the left only to the extent of 7 per cent. Hence, in respect to cholera in any campaign on the north-east frontier of India in which it was necessary to

employ British troops, it would be well to take a regiment from the plains.

Immunity from a previous attack will not help us. There is no doubt that a certain immunity from a previous attack is gained, such as is the case in other infectious diseases. But this immunity in cholera seems to be limited to the epidemic in which it was gained. A man is seldom attacked twice in the same epidemic. Again, those who have passed through any given epidemic without being attacked likewise seem to gain for a time a certain immunity, but all such immunity is short lived.

As regards the previous medical history, scurvy and malaria have been held to predispose to cholera. Hence, for this reason, it would be well to reject all men with a strong scorbutic or malarial history.

The last point to be noticed in the matter of personal predilection is the question of hospital attendants. This will be referred to under hospital measures.

Selection of Season.—As regards season, this factor is on the whole unfavourable as regards campaigns near the endemic home of cholera, but favourable as regards campaigns outside the endemic home (that is to say, in the case of campaigns that could be finished in two or four months, as so many of ours have been). In the endemic home, Bengal, as shown by Macpherson's tables, comprising twenty-six years' observations, cholera deaths begin to rise slightly in October (from 5000 to 8000); in November and December they reach 11,000 and 10,000; in January, 9000; in February, 12,000; March, 19,000; April, 24,000; May, 16,000; after which we have a drop to 8000 in June, and 5000 for July, August and September. Hence, for all campaigns on the borders of Bengal, particularly on the north-east frontier, the cold weather is more unfavourable than the months from June to October. But still the largest amount of deaths occur in March to May; and it would be well to conclude all expeditions on the frontier by the end of February. The months in which campaigns should be carried on here occupy as it were medium place as regards mortality.

But outside the endemic area in India, as regards the N.W.P. and Punjab, and also in sub-tropical latitudes outside India—in the epidemic area—from October to March is the favourable season for campaigning as regards cholera. The hot and rainy seasons are to be avoided. The explanation of the above differences is to be found in the fact that it is a relatively high temperature and a relative amount of moisture that favours cholera.

Clothing.—As regards clothing, the great object is to prevent chill. Our men should have no deficiency of clothing. Thus, in the first place, woollen clothing is indicated. Secondly, local chill to the abdomen must be especially guarded against, to prevent all catarrhal conditions of the stomach and abdomen. For this purpose, I think the flannel waistcoat, sufficiently prolonged, as worn by the French in Algeria, would be preferable to the

ordinary cholera belt. Woollen clothing in relation to cholera is especially preferable to linen. It must happen that our men, on occasion, cannot find time or opportunity for having their clothing washed. Now, all impregnation with organic matters, and all offensive odours, are especially to be avoided as regards cholera. And, in the matter of cholera, Pettenkofer draws especial attention to the fact that linen and cotton clothes which have been worn, smell much stronger than woollen clothes. "A woollen shirt that has been worn for a month does not smell nearly so badly as a linen one that has been worn for a week." Jaeger's sanitary wool clothing is here again especially indicated. Finally, all damp clothes must be scrupulously avoided.

Marches.—As regards marches generally, we postpone our remarks till we come to the section on marching out to avoid cholera. But it will be convenient here to indicate the precautions to be observed on board transports carrying coolies and camp followers up the enemy's country, as is the case in our north-east frontier campaigns in India. We have before seen how cholera seized the coolie corps in the left columns in Looshai. We must have camp followers for these campaigns, and these camp followers have to be passed up through the endemic region of cholera. Hence, the greatest precautions are necessary.

Transports.

Now, hitherto the process of selection has not been sufficiently applied to coolies; the transports have been overcrowded, and the camping grounds on the rivers have been as unsanitary as they could be, and with as bad a water supply as possible. Although these facts have all been pointed out, yet it may not be superfluous to point them out again, for we maintain that, with the following precaution, cholera may be kept from epidemically attacking our camp followers.

First, then, with regard to the transports. Such transports will doubtless have long lain in the Hooghly, or sometimes in the neighbourhood of Calcutta, exposed to all the chances of infection by means of particles of cholera stools in the air, or by some of the crew dying on board of cholera, &c. In fact, we can easily imagine how, in such a place, a transport would be infected. On the likelihood of any campaign taking place, Government should at once see after its transports, and thoroughly cleanse and disinfect a requisite number. They should be taken out to sea, and the bilge water, and holds, and every part of the vessel thoroughly washed by means of a hose and forcing-pump. Previous to this pumping, every part must be scraped and scrubbed, then the whole vessel must be well douched with sea-water, and the precaution especially must be taken not to cease this douching until the water pumped out of the hold is as clean as that last pumped in. Next, let all the various parts of the ship be aired. In Russia a large air-pump is used for this purpose, and this forcing of air is rigorously prescribed by the Minister of the Interior. The vessel thus washed and aired is to be fumigated and disinfected. The disinfection of the hold and lower compartments must be effected by corrosive-sublimate solu-

tion, according to the greater or less quantity of water accumulated in the hold.* The solution is poured into the hold, &c., and stirred about for an hour. After this it must be left to stand for twenty-four hours, then the disinfected water pumped out, and sea-water pumped in and again emptied, and the hold again filled with corrosive-sublimate solution, and finally emptied.

For cabins, &c., the floors and contents must be scrubbed, and then disinfected by means of corrosive-sublimate solution or carbolic-acid solution.

Finally, let all the hatches and ports be closed, and the whole vessel fumigated for twenty-four hours with sulphurous acid.

The transports thus cleansed and disinfected should remain outside the Hooghly till wanted, they should then be brought up, the coolies embarked, and the vessels should at once make their way.

As regards the coolies, we have seen that hill-men are not to be selected. It must be just as easy to get labour from the N.W.P. or from the plains of Bengal, as from the hills of Bengal. All the coolies must be provided with new suits and blankets, and thoroughly washed, after having previously been medically inspected. They should be formed into a separate camp away from the city, and kept under observation for at least three days. (Dr. Pringle has lately fixed the period of incubation of cholera at two days). All cholera cases to be at once weeded out. Their provisional camp must enjoy all that sanitation (as understood in England) can afford. They are then to be marched down to the ghât, under surveillance, in detached bodies, and at once embarked. No rags, or indigestible food, &c., are to be taken on board. We now start with a healthy vessel, and a healthy body of men, as far as we can possibly meet the case. We have next to land them in a state of health in the enemy's country; having passed them safely through the low country, our task will be accomplished.

The great factor of *overcrowding* must be attended to. Not that overcrowding, *per se*, of course can cause cholera, but, once a case started, it would immensely favour the formation of an epidemic. At the Sanitary Conference held in Rome in 1885, it was held that on steamboats 'tween decks must have at least 9 feet of surface or 54 cubic feet, and on sailing vessels 12 feet of surface, or 70 cubic feet for each pilgrim. Now, in Looshai and Duffla, 12 square feet were allowed per man; as a matter of fact, in Looshai they only got a little over 11 square feet. Dr. Wise, as we have seen, especially remarked on the overcrowding. Again, in his history of the Looshai expedition, Colonel Woodthorpe records that the medical authorities at Calcutta protested without avail against this factor; "the ordinary precautions to prevent overcrowding seem to have been entirely disregarded, and

* The instruction for disinfection of vessels prescribed by the Ministry in Russia allow 1 lb. of the sublimate for each 1000 lb. of water in the hold; 1¼ to 2½ lb. of sublimate can be dissolved in 50 lb. of water.

the result was what might have been anticipated." With respect to this item, Dr. J. Macpherson writes, "The more closely packed a regiment is, the more likely is it to suffer severely from cholera, and separating the men is one of the first steps toward stopping an outbreak." But it is far better to allow for this in the first instance, and we would urge that each man should have certainly not a less quantity than 12 square feet allowed him. But it would be better to build special transports for such work; a double-decked vessel, both decks above the water, could easily be built, without any sides around the deck, so as to allow free perflation of air. The disposing of men below in close ill-ventilated 'tween decks can be anything but healthy. Large flat-bottomed boats with an awning over them, could be easily tugged up the river. At any rate, let large windows be cut in the sides of all transports. Having thus taken precautions to ensure proper ventilation, we next come to the question of the food. Now, in Looshai, the men were allowed to land to cook their food. In the series of instructions in view of cholera, used for the transports in the Duffla expedition, the men again are to be landed for cooking purposes. The precaution is first to be taken to always inquire whether there be any cholera in the neighbourhood. We have seen how futile this latter precaution was in the Looshai war. The men should not be landed at all for cooking. The banks of the rivers in Bengal are always a source of cholera. By providing plenty of transports—which is only a question of money spent in saving life—there would be plenty of space for cooking on board. Let the men cook their food, then, in relays at the end of the vessel; and let them on no account, during any part of their voyage, hold any communication at all with the shore. After cooking is over, let this portion of the vessel be washed, scrubbed, and disinfected.

One of the chief reasons for not disembarking the men, is the filthy water supply that would await the coolies. And here it will be convenient to show the causes of the large amount of mortality from cholera in former years among coolies going up to the hills. Dr. De Renzy has pointed out, in one of the most convincing chapters on cholera with which I am acquainted, how from the very commencement of emigration, *viâ* the Brahmaputra (and therefore in strict relation to our present subject), the coolies suffered from "such disastrous epidemics" of cholera that in 1870 the Government of India "was forced" to investigate the matter, and provisions were made for the cubical space on board the steamers, the ventilation and cleanliness of the vessels, food, clothing, water supply, &c. The voyage up the Brahmaputra lasted seventeen days, and during the trip the coolies were inspected by three resident medical officers, at intermediate stations. Still the epidemics continued till Dr. De Renzy took up the reins of sanitation in 1877. Turning his attention to the water supply, he was assured that it, like Cæsar's wife, was above suspicion. The coolies were said to be supplied with water pumped from the great river—and only so pumped in mid-stream

—and then stored in iron tanks. He also found that the native crews who used this water were free from cholera, whilst, further, European passengers—and therefore susceptible predisposed material—who used this water were also free from cholera. Hence, here evidently was a crucial proof that it was not the water causing cholera, but indeed certain mysterious climatic, telluric, atmospheric, and meteorological causes, entirely beyond human control. However, Dr. De Renzy, one morning during the progress of an epidemic, got up early, just as the coolies were rising. Two tubs half full of water were placed close to the entrance of their latrines for ablution after defæcation; and *he saw the coolies rinsing their mouths with this water, and taking it away in their drinking vessels.* On inquiry, he found that there being but one tap to their water tank, they could not supply themselves sufficiently from this tank, and *so they were in the habit of drinking from the tubs,* which tubs *were for ablution after defæcation;* if once, then, the latter were contaminated with the excreta of a coolie seized with cholera, or with the preliminary diarrhœa, a splendid "culture" for the virus was furnished. Dr. De Renzy had this state of things at once rectified; the "culture" tubs were abolished altogether; a pump was let into the side of the vessel, and water pumped from the middle of the stream into a long closed cistern provided with a number of taps, whilst water for ablution was separately supplied from the river. *The cholera mortality at once fell, and has never since reached its former figure;* and the result has been that the coolies have been placed in the position of the native crews as regards their drinking-water. I have gone into this fully in order to illustrate the method of water supply to be followed out by the authorities for our transports; but in addition I would urge some of the simple means of purification by alum shown in the first part of this work.

But this is not all. We have to show now why we should not land the men, and also why we have laid stress on English principles of sanitation at the primary depot. Dr. De Renzy did not succeed in entirely stopping cholera, for he did not succeed in embarking a non-cholerized community. In his representations on the subject he showed how the coolies at the depots drank water from the innumerable filthy tanks in their neighbourhood, and how, as a consequence, these depots were infested with cholera. He also showed up the condition before alluded to at Dhubri. But, as a consequence, only "very unsatisfactory work" was done in the way of remedying these matters, and hence we have laid down that at the depots the coolie camp should enjoy sanitation on the principles that obtain in England—the principles of Budd, Thorne, Buchanan, and Parkes.

As regards the injunction never to land the coolies, although Dr. De Renzy in 1878 drew attention to the third source of contracting cholera—viz., the contaminated water at the encamping grounds on the river, which water was in many cases *very foul ditch water*, yet it *remains unchanged* (August 9, 1884), and is as

bad as it can be. How bad that is can be gathered, that in one encamping place the drinking-water is the "water effluent from a washerman's village, in which cholera is a perennial pest." Hence, again, we say never land camp followers during their voyage in the transports.

I will now briefly recapitulate the measures to be followed out in the matter of camp followers and their march to the scene of conflict; for the management of these coolies is of inestimable importance to the health of the expedition at large. If cholera once becomes epidemic in the transport and coolie corps, it is evident what a source of danger will threaten the fighting element. The following, then, are the indications :—

1. Avoid hill coolies in selection.

2. Cleanse and disinfect and segregate, till wanted, the transports.

3. Medically inspect and segregate all coolies at the depots.

4. At the depots let the sanitation be conducted on principles obtaining in England.

5. Attend to ventilation and water supply on the transports.

6. Provide a complete new kit of clothes and blankets for each coolie before embarking him, and make him undergo ablution before thus clothing himself.

7. On no account land the coolies on the voyage for any purpose.

The remaining rules on board the transport are much the same as those to be laid down for camps on land; they include conservancy in its widest sense, such as cleaning and disinfecting regularly the decks; cleaning the coolies' clothing; attention to the latrines, attention to the food as regards soundness of supplies, &c. The importance of attention to cleaning the decks is shown by the details of the outbreak on board the s.s. *Dorunda*, the outbreak on which is detailed later on. Surgeon-General Cornish shows how the medium of infection was probably through the sand employed for holystoning the decks. At Priok, the supply of white sand for this purpose had run out. Fresh sand was brought on board in bags, which was found to be black and filthy, turning the boards black instead of white. This sand was obtained from spots that had been probably contaminated with cholera excreta. It contained organic impurity, and was most offensive in smell. Dr. Cornish holds that in it a cholera soil was brought on board the vessel.

In the Duffla expedition also it was wisely recommended that regular fumigation of the decks should be carried out during the day, by hanging up pieces of cloth saturated with MacDougal's powder (8 oz. to the gallon). The above principles will be found in greater detail presently. Meanwhile, there must be careful scrutiny twice daily on the part of the medical officers for the earliest symptoms of diarrhœa or bowel disorder. Such is a general outline of the principles to be undertaken. I believe that if these principles are followed, there will be no outbreak of cholera. It is possible a case or two will occur; if so, isolate

them on the lee side of the vessel, taking advantage of any boats, and using all the precautions regarding bedding, dejecta, &c., to be mentioned later. But with a properly selected and segregated coolie corps, who have undergone medical inspection for three days before immediate embarkation on a properly disinfected transport, and who, during the voyage up the river, are not allowed to land, we believe that a cholera outbreak will not occur. But should it do so, the question at issue, then, is fraught with difficulty. For two courses are open: To land, and thus to undergo the danger of fresh infection, whilst the vessel is again disinfected, the sick separated from the healthy, and the healthy strictly kept in quarantine; or else to land the sick as circumstances allow, and to hurry up out of the endemic region with all its insanitary abominations as soon as possible, and so to get to the purer hill country beyond. Of these alternatives we prefer the latter. By taking the first, the risk of fresh infection must be run, for to be of any use the length of stay on shore must be three days; whilst by hurrying up to the front at once, the vessel's company can at once be landed in a virgin country, and strictly isolated from the rest of the troops.

Finally, as regards the coolie corps, to show how real is the danger of importation by its members, I quote from the Report of the Sanitary Commissioner with the Government of India for 1881. It is there stated that out of 221 coolie ships, carrying from 300 to 600 men, leaving India for the American colonies in ten years, thirty-three had cholera on board, in sixteen of which the epidemic lasted for more than sixteen days. Now, be it remembered that such ships would, in a day or two, gain the open sea, and the disinfecting power of the pure sea air is hostile to the continuance and spread of the cases; also their evacuations are easily disposed of and left behind the ship. But how different is the condition when such infected ships, instead of proceeding out to sea, journey for sixteen or seventeen days up a river, whose banks are perennially infected with cholera virus; the landing daily the coolies for cooking, &c., must inevitably add fuel to the already lighted flame, considering the conditions on those shores we have alluded to. And, moreover, the mere fact that 33 ships out of 221 left the port with cholera already on board, points to the absolute necessity of the previous medical inspection and isolation for at least three days of which we have spoken.

Regarding the transports for the fighting element, the same principles are indicated. Careful preliminary inspection of the men, and disinfection of the transports are, of course, as necessary in the one case as in the other. Koch has pointed out how constant must be the opportunities occurring in every loaded transport for infection from one individual to another. The men, likewise, must not be permitted to land. One element of danger will be less on the vessels for the fighting men; greater space and therefore less overcrowding obtains. Lastly, in all transports it is of the greatest importance that the decks should be kept dry in

cholera localities. By such means, which apply equally to all cases where cholera has appeared in a body of troops or camp followers in transports on any river, the risks hitherto connected with conveying large bodies of men on flats up the rivers in Eastern Bengal, will be reduced to a minimum, and in the proportion in which these precautions are carried out, so will it be found "that the spread of cholera is governed by influences which are altogether not *beyond*, but *within* human control."

Before closing the subject of transports, a few words may be devoted to the examination of the dictum so emphatically held by Cuningham and Fayrer that "ships do not carry cholera to other countries." For if this be true, it is at once evident that the preceding precautions are but a work of supererogation. In the first place, in a well-ordered ship it is manifest that there is less chance of cholera being imported by ships, for the stools of the patients—the chief media of infection—are at once disposed of and cast out of the ship. But, that ships do carry cholera is founded on evidence so strong that I must confess I am unable to imagine how it could be stronger. The evidence of all the epidemics that have occurred in England is irrefutable on this point. The same remark is to be made with the evidence of the outbreaks in America. The history of cholera portrayed by Hirsch positively teems with examples that completely refute the above dictum. To take one example: on October 10, 1871, four days after the last case of cholera at Stettin, the s.s. *Franklin* sailed thence for New York with 486 'tween-deck passengers, 55 cabin passengers, the ship's company, a cargo of merchandise, and nineteen bales of rags packed in canvas. On the tenth day out cholera broke out. By November 6th, when the ship arrived in the quarantine harbour in Halifax, forty-two men had died. On November 6th and 7th two men from Halifax went on board, and were employed in coaling and watering, and "were exposed for some hours to the poisoned air of the ship." Both were taken on the same day. From one of them the disease extended to his family, and then in widening circles through his village. No cholera had been present in Nova Scotia since the spring of 1866, when the s.s. *England* had arrived with some cases on board. Can anything be clearer than this? The history of the importation through the s.s. *England* is equally clear. Here infection arose on the arrival of this ship with cholera on board. The whole western hemisphere had been quite free for years previously from cholera.

A striking history of cholera imported on board ship is related by Surgeon-General Cornish. The s.s. *Dorunda* left Blackwall on October 20th, 1885, bound for Brisbane. Up to its arrival at Priok, in Batavia, the health on board had been perfectly satisfactory. The object of visiting Priok was to take in coal. Now, the coal depots were resorted to by the native workmen as latrines, and the surface of the coal enclosures was polluted by their filth. Cholera was present at the time, as Dr. Cornish shows by very positive testimony, although "it was not known officially." On

November 28th, the vessel left Priok. Suspicious cases then occurred on December 2nd, 5th, and 6th. On the 7th and 9th unmistakable cases occurred. On the 10th twenty-four cases were admitted, and the epidemic then continued till the 21st. Space forbids the enumeration of further cases of cholera importation on board ships, but, in conclusion, I would draw attention to the explanation given for the facts so awkwardly suggestive of importation. Dr. Cuningham, holding cholera to be but the result of a great atmospheric change, asks, "Is it strange that it should first appear in centres of population on the coast, in the seaboard towns, where human beings are congregated." Secondly, Inspector-General Lawson, in a paper dealing with outbreaks of cholera at sea, holds that they are due to "pandemic waves." There is an excellent review of this theory in the *Indian Medical Gazette* for November 1887. These pandemic waves are "factors for cholera which the ships encountered in the localities where they suffered." But, as the reviewer in the above periodical aptly remarks, "The paper under notice is an excellent example of how these waves are invented. The cholera factors who dwell in mid-ocean, and occupy fresh localities from time to time, are curiously discriminative. *Not a single instance is given in this paper in which they meddled with a vessel sailing northwards from a port in which cholera did not prevail.*" I would ask whether either of the above explanations is more in consonance with the most ordinary common-sense than the explanation by human intercourse?

The Camp.—The remarks that follow concerning the camp apply equally to the original camping-grounds or to the camps chosen when it has been necessary to move the troops on account of an outbreak.

First, as to the geological structure, *per se*, of the soil. This has no influence of itself. Macnamara points out in the great dissemination due to the fair at Hurdwar in 1867, how cholera broke out "on the rocky soil of the Punjab, the sands of Western India, and down into the alluvial soil of the Gangetic Valley." The disease took root in regions presenting every variety of soil, and situated on the most opposite geological formations. Rocky, dry ground even cannot be held to afford immunity. Townsend shows how cholera broke out in the Central provinces in villages situated on hard bare rock, subsoil water also being absolutely non-existent. Hence, the geological structure, *per se*, is of no influence. But, nevertheless, certain soils are more prone to cholera than others; rocky, dry ground is least affected; whilst loose, porous, or alluvial soils are most prone to the disease. The factor, indeed, in any locality is its suitability or otherwise for stagnation of water, and decomposition of organic matter. It is thus that alluvial or porous friable soils are favourable to cholera, whilst dry, rocky soils are more favourable for conservancy. Thus, also, all those soils characterized by humidity of which we have spoken in treating of malaria, are also predisposed to cholera. Thus, the first indication is to choose as dry and compact a soil as possible to camp on.

Next as to height. Height above the sea gives, it is true, no absolute immunity, for at the highest point the laws of sanitation may be equally neglected as at the lowest. Still, *cæteris paribus*, the amount of sickness diminishes in proportion to the height ascended above the plains, and if any district be seized, it will generally happen that the low-lying parts are first attacked. Dr. Farr deduced the law from his experience, that the proportion of deaths from cholera amongst the inhabitants is inversely as the elevation of the ground. The same explanation offers itself for these facts—viz., in the low-lying ground we have copious ground saturation and opportunity for deposition and permanent resting of organic matter. If the laws of sanitation are neglected on the hills, cholera will rage on the hills; of this fact Murree is a good example. This sanitarium was a standing monument of the effects of absence of sanitation resulting in typhoid fever and cholera, and affording a perfect bed of "selection" for the specific virus when imported. Thus, the second rule for camps is to locate them on as high ground as possible; avoid places at the foot of any declivity, or trough-shaped depression.

Thirdly, for the same reason, avoid camping near the banks of rivers or lakes; it has been well proved that the amount of sickness from cholera diminishes in proportion to the distance from river banks. All the above conditions have been typically illustrated in various outbreaks. Thus, with regard to the latter injunction, in the statistics of cholera in Madras by Balfour, it is shown that within forty-eight years there were 152 outbreaks of cholera among troops on the march, and of these 102 occurred whilst the men were marching along a river bank or in its immediate neighbourhood. Again, Graves, in his *Clinical Lectures*, mentions that in 1817 cholera broke out amongst a force of 10,000 combatants and 80,000 camp-followers under the Marquis of Hastings, when encamped on the banks of the Indus. About 7000 combatants and 8000 followers died within a very short time. The general then broke up his camp, and removed it away till he got to dry ground, and the attack ceased. And as regards the good effect of moving off the plains to the hills, Roth and Lex quote an instance occurring in the French army in Algeria, in which cholera broke out in the camp located on the plain between the rivers Kyos and Malonia, in an expeditionary corps of 15,000 men, 3000 of these died in the short interval from the 14th to the 27th of October (1859). The camp was struck, and moved to a high plateau: on November 10 the mortality had ceased.

The fourth indication as regards camp is ventilation. Let the camp, besides being on high and dry ground, be exposed to the prevailing winds. Let the tents be "dislocated" as far as is conformable to the military necessities of the case. Ventilation is, of course, bound up with "overcrowding," and no soil is so favourable for the spread of cholera as that on which an overcrowded population rests. We have seen how this factor of overcrowding came into play on the transports in the Looshai expedition, let it

not therefore come into play in our camps. And, as regards the ventilation, especial care must be taken so to place the latrines that no effluvia thence be wafted over the camp. Lastly, the number of men in each tent should be lessened.

The fifth indication is frequently to change ground. The accumulation of fæcal matters and organic detritus, resulting from a too long occupation of the same ground, must inevitably favour the spread of cholera when once it has invaded a camp.

Conservancy.

Finally, all the general measures of camps, such as drainage, conservancy, &c., must be especially looked after in cholera times. We have already seen how the organism of cholera is at once killed by drying; the indication, therefore, is to make our camp as free from soil moisture and moist organic detritus as possible, so as to deprive it of its special conditions of environment.

Fatigue duties.

In connection with the camp, also, it must be laid down that all fatigue duties must be carried on with as little stress as possible. Fatigue, as we shall see, is an important factor in cholera.

Drinking water.

Food.—I now come to the all-important question of food. I will proceed at once with the question of drinking-water. I have already expressed my opinion that, as a rule, epidemics of cholera arise from cholera-infected drinking-water. I, however, say, "as a rule," for I do not wish to incur the charge of "unjustifiable scepticism" as regards other channels. Were this a chapter written merely as regards cholera in Europe—always supposing that cholera has visited Europe, and that the collective professional talent of Europe has not made an erroneous diagnosis of the nature of the epidemics of 1831, 1848, 1853, and 1865—we should hold it unnecessary to do anything more than state the bare fact. But we are dealing with cholera in the tropics, hence, before indicating the precautions, I must indicate the basis on which I rest these precautions. And the basis is this: "If, in a given locality, a number of cases of illness suddenly occur, exclusively confined at the beginning of an epidemic to one portion of the population, to those, namely, who had got their water supply from one spring or one conduit; if it be proved, further, that this water supply has been contaminated by sewage, or by the cholera poison contained in the sewage; if it be shown, further, that the affected inhabitants have everything else in common with the exempted (the same kind of weather, the same dwellings, the same soil), differing from them in the conditions of their existence only in the use of the impure drinking-water; if, lastly, the epidemic comes to an end, as it has been found to in many cases, with the closure of the poisoned spring; then, in my opinion, the inference *post hoc ergo propter hoc* is warranted concerning the origin of the disease so absolutely, that even the most rigorous scepticism must be satisfied with it." Such are the words of Hirsch, except that he is talking of enteric fever; I have substituted cholera, for they are strictly applicable to cholera, and moreover, as Ernest Hart has shown, the liability of a place to cholera is exactly its liability to enteric fever and *vice versâ*. Now, have we such a typical case? We have partly shown such a

Hirsch.

case already in narrating Dr. De Renzy's experience on the Assam rivers. For here we have seen three separate bodies of individuals, enjoying "the same weather, the same dwelling, and the same soil," but only differing from one another in the source of their drinking-water. The crews and Europeans who drank water uncontaminated with cholera dejecta had no cholera, the coolies who, on the contrary, did so, had cholera. The completion of the proof must now be given. The annual death-rate previous to the change in the arrangements effected by Dr. De Renzy was, for 1874, 3.00 per cent.; for 1875, 3.28 per cent.; for 1876, 1.70 per cent.; 1877, 1.46 per cent.; and for 1878, 2.70 per cent. The year 1879 witnessed the improved arrangements, and "this year was a year of unparalleled mortality from cholera in Assam." But the mortality was lowered at once to 0.81 per cent. in 1879—the year of unparalleled mortality in Assam. In 1880 it was 0.42; in 1881, 0.88; in 1882, 0.65; in 1883, 0.65. But it may be argued, the cholera did not disappear, although there was furnished an uncontaminated water to the coolies. True, but we have shown that this kind of water was furnished only on the transports, whereas, before embarking, the coolies drank a highly "unsatisfactory" and "offensive smelling" water, whilst at the encamping grounds they drank water "as bad as it could be." The whole of this reasoning was, however, termed by the Sanitary Commissioner with the Government of India a "hasty assumption," and the abatement of the disease attributed to "an abatement of epidemic influences." But, as Dr. De Renzy showed, the "epidemic" of 1882 was the greatest that has occurred in Bengal for years; this "epidemic" also affected Assam, whilst two other great epidemics, 1879 and 1883, also affected Assam and Bengal, and yet in these three the mortality amongst the coolies of Assam and Bengal in the steamers has been less than it ever was before the change, and in the time of less severe visitation. Truly, as Lebert says in his monograph on cholera, "to deny an influence to the water in the diffusion of cholera is a scepticism utterly unjustifiable." Turn we now to another authority, Prof. Maclean. This authority, in commenting on Pettenkofer's views, put the matter succinctly, if not agreeably, to those concerned. "At one time Pettenkofer believed in the water theory of transmission of both cholera and enteric fever." This belief he has now "finally abandoned, apparently by the simple and easy process of throwing overboard the evidence so patiently accumulated by English observers of the highest reputation—a process it appears to me more convenient than convincing."

Evidence of De Renzy for Assam.

Prof. Maclean.

The evidence in the same direction afforded by Madras is perfect. Taking the deaths in the sixty years ending 1883, in which an improved water supply had been introduced and completed for Madras, Surgeon-General Cornish showed that the average number of deaths per year was 121, whereas in the decade ending 1866, when the old contaminated water-supply was used, the average yearly deaths were 1959.

Evidence in Madras. Surgeon-General Cornish.

His successor, Surgeon-General Furnell, gives still more con-

Surgeon-General Furnell.

vincing demonstration. This officer, who has done so much for the prevention of cholera, affords proofs which would appear to be unanswerable. Let us, therefore, enumerate some of these proofs. In his address at the annual meeting of the Madras Branch of the British Medical Association, held in January 1886, Surgeon-General Furnell showed how, for many years prior to the introduction of the Red Hill water supply into Madras, the number of deaths amounted to hundreds and even thousands; but from the year 1872, when this new water supply was first opened, the reduction of mortality has been enormous. In 1872 the deaths were five only; in 1873, six only; in 1874, *nil*; in 1880, two only. During 1875, 1876, and 1877, this reduction was interrupted. But these three years were years of famine, in which people from the neighbouring districts flocked into Madras, "many of them simply to lie down and die," and almost every death was perfunctorily registered as cholera; or, to use Dr. Furnell's words, "to save trouble were registered as cholera." Again, from 1881 to 1884, the deaths again rose, but during these years there raged one of the severest epidemics of cholera on record in Madras, yet, contrasted with the former huge mortality, the deaths were comparatively few. But mark, Dr. Furnell found on careful inquiry that *these deaths came from outlying districts where the Red Hill water was not laid on.*

Madras.

Passing to other localities in Madras, Dr. Furnell instances the case of Guntur. For many years this place was famous for cholera epidemics, "a sort of head-centre for cholera." Since 1868 it has been quite free from them, even when the disease was raging in the country around. During the famine, when it was prevalent throughout the district in the villages close to Guntur, and also in the famine relief camp situated two miles to the north of it, there was no case in the town. It owes its immunity to the improved water supply, which water supply is carefully conserved by men appointed by the municipality to prevent the people polluting it who resort to the reservoirs for water. Again, take Pondicherry. Here cholera is practically unknown, even when raging in the localities around. It has an artesian well supply, and a large lake, some miles outside the town, from which the water is led by pipes into the town and distributed by hydrants. Cuddapah affords another crucial instance. A suburb of this town, Yerranukapalli, suffered severely from the disease in 1883. Through this suburb flows the stream Bogra. Cholera broke out when the stream was sluggish, and was confined to the Sudras, a caste living on the banks of the rivers, and using its water for every purpose. Just previous to the outbreak of cholera, clothes of cholera patients from a neighbouring village had been washed in this stream above. Now just across the main road, within twenty yards, is a hamlet inhabited by Malahs (pariahs), amongst whom not a case occurred, but then these people were not allowed by the Sudras to draw water from the Bogra, but used water from a neighbouring well. What greater proof can be desired of the agency of water? Dr. Furnell aptly remarks,

Guntur.

Pondicherry.

Cuddapah.

it is absurd in all these cases to suppose that "atmospheric," "telluric," or "local" influences were at work thus partially in these localities, or that they suddenly became benign in a small spot in the midst of an infected area. Nor was it due to sanitation, for "if its being dirty was the only necessity of having cholera, Madras ought to have suffered handsomely." One final instance, given by Dr. Van Gazel, of Gangam, bears quotation. In 1885, cholera raged all over the Gangam district, but Gopaulpore suffered immunity. The villages in the neighbourhood of Gopaulpore were all affected, communication from which daily occurred with Gopaulpore. But the latter village had absolutely no tanks whatever. Gangam.

Turning next to the Central Provinces, Surgeon-General Townsend, C.B., the sanitary commissioner, shows how cholera has in a vast measure disappeared from Nagpore, a city of nearly 10,000 people. The number of deaths in the city during the seven years subsequent to the introduction of pure water is less than one-seventh of the number prior to that event (177 against 1264). But whilst the mortality declined in Nagpore, there has been no corresponding decline in the district, epidemics having on the contrary been prevalent. Evidence in Central Provinces. Surgeon-General Townsend.

Let us now treat of the Punjab. Surgeon-General De Renzy when sanitary commissioner of the province, showed how the sudden outbursts at Mian Mir, Peshawur, and Rawal Pindi, were entirely due to sudden outbursts of water-poisoning by cholera excreta. The comment of Dr. Parkes on this valuable paper is worth recording at the present day: "This paper takes us out of the mythical regions of epidemic distribution to the firm land of observed and recognized facts." The recent epidemic again in the Lahore Central Gaol is equally convincing. In 1887 a severe epidemic of cholera broke out in the Lahore Gaol. Dr. Dickson, the superintendent, has issued a report, showing the origin of the outbreak to be due to an unprotected water supply. Two bunniahs who were attacked and died introduced the disease into the district gaol through the milk which they supplied. However, the district gaol did not suffer severely, as it received its water supply through reservoir mains and hydrants. The Central Gaol, built on an adjoining site, received an impure water supply from wells; to this gaol prisoners had been sent from the surrounding district gaols, which were constantly receiving prisoners from the surrounding cholera stricken districts. Dr. Dickson, in his remarks on the causation of the epidemic, thus writes:—"To me it is abundantly evident that had we a protected water supply at the Central Gaol—I mean reservoir pipes and hydrants—never again would the gaol suffer from the epidemic of cholera; the disease might be introduced, but it would not spread." It is difficult, nay, impossible, to see how seasonal influences could affect the Central Gaol, but pass over the adjoining district gaol. Evidence in the Punjab. De Renzy. Cholera in Lahore Gaol.

Lastly, as regards the evidence in Bengal. Macnamara has shown how, during the years from 1826 to 1864, the European regiment in Calcutta had an average of 35 cases of cholera Evidence in Bengal. Macnamara.

per annum. In 1865, for the first time, this regiment was supplied with pure water, and from this date the number of cases has fallen to two per annum, although the climatic environment is the same, and although there is the same surrounding native population suffering constantly from the disease. Surgeon-General De Renzy has shown similar facts more fully in his valuable paper on "The Extinction of Cholera Epidemics in Fort William." Here the facts "confirm, with the completeness of a demonstration, the opinion held by most authorities in India that cholera is mainly communicated through the medium of water."

De Renzy.

The recent history of cholera in Calcutta is especially valuable. It is manifest that, in a large city, it must be more difficult to prove the facts of direct or indirect human intercourse than is the case in a localized station. But still the problem when worked out with discriminating energy is not insuperable. The medical officer of health, Dr. Simpson, in his recent report submitted to the municipality for 1886, shows the dependence of cholera on infected water, and its independence on climatic causes. Of late there has been an increase of the disease in the city. "If," Dr. Simpson writes, "cholera prevalence is to be explained solely by seasonal influences or waves, the behaviour of these waves, as shown in their relation to Calcutta, Howrah, and the suburbs, is somewhat remarkable. Calcutta is practically surrounded by Howrah and the suburbs, yet the same seasonal influences during the last five years have had a most intense effect on Calcutta compared with the previous years, whilst on the town of Howrah and the suburbs the effect has differed little from usual. Assuming that meteorological conditions favourable to the promotion of cholera prevalence existed, and that for a series of years some peculiar combination of electrical, chemical, astronomical, telluric, cyclonic, and other unknown conditions were present, which had been absent previously, it has still to be explained how such a condition, in pervading the whole city, elected for its operation special localities; why it was less effective in its work of destruction in the south part of the town than in the north; why even in the north part some localities remained stationary, and others improved under these peculiar conditions, whilst on the riparian side generally districts have been attacked with a virulence equalled only by a few localities scattered here and there over the northern and central portions of the town." The climatic hypothesis being thus demolished, Dr. Simpson next shows the true explanation of the increased virulence. In the affected localities a scarcity of the water supply has occurred. Houses which formerly had a water-pipe connection with the public filtered supply carried up to the second story are now without water on the ground floor. Consequently, a return has set in to the more frequent employment of water-carriers, and to the greater use of wells and tanks. As regards the latter, the dangers of drinking infected water is greatly increased by contamination with dirty vessels or mussacks, or storage in infected houses, whilst the following table of Dr. Simpson shows the difference in quality

Dr. Simpson.

between the filtered hydrant water and that obtained from tanks and wells :—

	Amounts per Mille.		
	Chlorine.	Free Ammonia.	Albuminoid Ammonia.
Tank water	360	14.60	22.20
Well „	291	9.03	10.10
Filtered hydrant water . .	5	Nil	0.02

The scarcity of water above alluded to has been brought about by the larger area for supply, and the enormous waste of water and its application to other purposes. To sum up, the localities in Calcutta for which at present cholera shows a preference, are characterized by a defective water supply, causing a resort to the polluted wells and tanks which stud these regions.

Reviewing all this evidence, we see that evidence involving practically all parts of India coincides in one direction. The investigation of those in chief sanitary authority bear testimony, as conclusive as testimony can be, that cholera-polluted water is the cause of cholera epidemics. Nevertheless, such evidence has been passed over as one-sided, and held to be of no value. Summary.

Turning now to tropical countries outside India, the same results appear. At the Medico-Chirurgical Society Dr. James Johnson, of Hongkong, declared, that though the disease was frequently introduced there, yet it never became epidemic. And this he showed to be entirely due to the excellent water supplied and obtained from lofty reservoirs on Victoria Peak, and used by all the inhabitants. He was also in charge of a man-of-war which entered Shanghai harbour at a time when cholera was raging there. Some of the crew became infected. Immediately all on board were ordered to drink only distilled water; the ship steamed away north, and the epidemic ceased. Of course the answer is ready at hand for the epidemiological sanitarians : the cholera ceased because the ship steamed away out of the epidemic, telluric, and atmospheric influences. But, as a matter of confuting fact, *there were other ships, also infected, which likewise went away north, and in which the cholera continued to rage, until the shore water which had been taken on board was interdicted, and replaced by distilled water.* So much then for proof. I have proved not only that water is one of the media for conveying cholera, but that it is *the* medium, and probably the only medium in cases of epidemics. I conclude this part of the subject by once more insisting that the sudden invasion of a large number of any community by cholera is due to the introduction of the poison through the water supply; that such introduction is perfectly sufficient to account for all the vastness of an epidemic. Whenever cholera evacuations contaminate the drinking-water, we may expect to find the disease burst forth with the greatest virulence and fatality amongst those who use the water, and that were there no opportunity offered for such contamination by cholera Hongkong. Dr. Johnson.

Parkes. excreta, in the words of Parkes, "the investigation of cholera would come to an end from lack of material." With regard to the factor of water in producing cholera epidemics in Europe, I have purposely not strengthened my argument by drawing illustrations from this region, otherwise I had ample material. The history of the epidemics in London in 1832, 1849, 1854, and 1866 is conclusive on this point. An equally conclusive argument may be gathered from the recent epidemics in Spain. To those who wish to study the causation of the latter in Spain, I would recommend the admirable review of the whole history written by Mr. George Higgin in *Nature* for June 17, 1886. No clearer exposition of the causation of cholera can be desired than that given in this paper.

Thus, then, although cholera may be imported into any given camp, the disease will probably never become epidemic in that camp, unless the drinking-water becomes somehow or other infected with the motions. Hence, the first thing to do is to secure a good water supply. Such water supply should never be taken from a native village, nor even near a village. In times of cholera the uncleanly native deposits his ordure anywhere, and for choice near any stream, for purposes of ablution. The source of water supply must be *above* the camp. Having fixed on the source, keep it guarded by sentries. Next, let all water be filtered and boiled before drunk. Prof. Du Chaumont recommends distilling it on campaigns, but we fail to see how this process could be carried out sufficiently for the wants of any camp, unless at the base. The methods of purifying the water have already been entered into fully. Norton's tubular pumps, where it is feasible to use them, seem to us to supply the acme of perfection, for by them a pure water at the commencement can be drawn with greater certainty than by any other means. Again, if the campaign take place in the rainy season, means should be contrived to collect the pure rain water for use, care being taken that the collecting receptacles are in the first instance perfectly clean. We have already alluded to the precaution of taking the water from the middle of the rivers in Eastern Bengal and Assam, in the case of transports, and of drinking only from the "khalls," and not from the main stream, if compelled to land. Such water, thus selected, must then be filtered and boiled, or treated with alum. Lastly, the bheesties' mussacks must be kept scrupulously clean and disinfected. Three final cautions may be given with respect to the drinking-water. Water that is simply, and not specifically, impure, will directly predispose to cholera, by exciting diarrhœa, or catarrhal conditions of the alimentary canal. Secondly, saline waters will, in like manner, predispose. The indications are obvious. Thirdly, with reference to the reaction of the stomach in relation to Koch's bacilli. Hay has shown how this reaction is alkaline after a long fast. Hence he holds that, in the presence of cholera, we should avoid drinking water after a long fast, except solid food be first taken. Especially is this precaution necessary before breakfast after the long fast of the night.

As regards other fluids consumed in the diet. Let all milk be boiled, and let the villagers, from whom the milk is obtained, bring their cows to the camp to be milked; let them wash their hands in water and some Condy before milking. All vessels into which the milk be poured must be scrupulously cleaned. An instructive example of infection by milk was lately portrayed by Dr. Simpson, the medical officer of health in Calcutta, in connection with a limited epidemic of the disease occurring on board the *Ardencluthu*. Only one man who drank from a certain milk supply escaped. The native who supplied the milk admitted that he added water to the same. Several of his neighbours had cholera, and certain of their dejecta drained into the tank on which his house stood. The first case of cholera occurred among the milkman's neighbours on March 7. The first case on the ship in question two days later. Milk.

No rum ration should on any account be allowed. Cholera ever attacks the intemperate first, and cholera prefers alcoholic drinkers. In peace time it has been shown that in certain epidemics the mortality amongst soldier servants was 8 per cent. compared to the men of the same corps not thus engaged, whose mortality was only 2 per cent. This increased ratio was doubtless due to the irregular habits, increased pay, and greater immunity from restraint of the soldier servant, affording him increased opportunities for drink. Alcohol also, besides, renders the body less able to withstand disease, deranges also the stomach, and causes the healthy acid secretion of the stomach to vanish, hence depriving the body of its natural protection against the cholera poison. Drunkards have ever been found by Dr. Dickson, as he showed in his paper at the Epidemiological Society, to suffer most. Alcohol.

Bread should not be eaten new and damp. Bread one day old should always be given out. Damp bread, says Pettenkofer, forms a ready nidus for the poison. In cholera camp the bakery and cookhouses must be removed from all sources of infection. How bread in India may spread the infection in cholera times was shown in the *Indian Medical Journal*. The unsanitary processes occurring during the bread-making in native bakeries must be seen to be believed. Avoid all unripe fruit, and avoid all excess in eating fruits. Let the meat rations be well cooked; theoretically it would appear, from reasons presently to be shown, that salted meats are better than fresh; but a continuous ration of salt meat is very prejudicial to health, as we have seen, and all salt rations, in our opinion, should be stopped on the appearance of cholera. Dr. Fairweather has given a most instructive instance in which cholera was introduced by the food: in 1871 there was very little cholera in the Punjab, but suddenly an outburst occurred in Delhi on November 28. On inquiry it was found that a man had died of cholera, whose discharges had flowed on to the earthen floor of the room in which he died. This death occurred on November 20. The floor is said to have been cleaned with cow-dung. On November 26 a burial feast was held; the food for the feast was cooked in this room, and the moist hot rice Solid food.

spread on a mat on the floor. The dead man belonged to the "Reghar" caste; almost all the males of this caste attended, in number about 350. Besides the Reghars, a few outsiders also came. The feast took place on midday, November 26; a few hours after cholera broke out in those who had attended it. Forty-seven cases occurred by November 29, and by December 4 these had increased to seventy-three. The disease did not spread from this centre. Now locality could not explain the outbreak, for mixed up with the Reghars were the Chamars. No Chamar, however, attended the feast, and no Chamar was attacked. As we have seen, also, a few men of other castes attended, living in the same neighbourhood; those who attended suffered like the Reghars, but those who were not invited entirely escaped. So much, therefore, for "telluric" causes. Neither could any "atmospheric waves" have excited the outbreak, for no other inhabitants of the district suffered, nor did it spread in Delhi. It was entirely limited to those men who attended the feast, and to the wives of those Reghars who had brought home with them portions of the feast. Can, therefore, asks Dr. Parkes, any experiment be more complete to prove that it was the food—masses of rice heaped up on the floor which had been covered with choleraic discharges—that caused the outbreak? I have related this instance in order to show that precautions concerning solid food are not to be regarded as "one-sided" delusions.

Flies. Finally, arrangements should be made to keep flies off all provisions. The carriage of disease by *flies* has only recently been much insisted on, but we can easily see that a fly that has fed on a choleraic stool, and afterwards perches on provisions, is a fertile source for transferring the poison.

Having now indicated what to avoid, a few positive directions must next be given. First, the food must be equal to the work; in fact, a more generous diet should be given in cholera times, in order to counteract any of the effects of fatigue, but this must not be carried so far as to cause over-eating, for the main guard against cholera, the healthy stomach, would then be overthrown. The food, besides being sufficient, must be varied as much as possible, so as to obviate all tendency to loathing from sameness. Great attention must be paid in inspecting the food supplies. Great cleanliness in the cooking things must be insisted on; a non-commissioned officer should be told off to see that the native cooks take every precaution. The early morning ration of hot coffee and bread, and the night rations to sentries, are more than ever necessary. Roth and Lex advise against a too preponderating vegetable diet as liable to set up catarrh. Meat should be roasted rather than boiled. Finally, as regards fluids, red wines, as in dysentery, are especially indicated.

In concluding our remarks on food, we would show the bearing of theory on practice. M. Babes, in the course of some observations in M. Cornil's laboratory on the conditions of life of Koch's bacillus, found that it will grow in milk, coffee, meat, carrots, leguminous vegetables, eggs, broth, and potatoes, but that it will not grow in fresh fruits, in acid liquids, in beer or wine, in cheese,

or in salted or smoked meat. These researches teach us, on the one hand, that especial care in roasting or boiling must be taken in preparing those articles of food in which the organism is capable of growth, whilst the fact that it will not grow in wine or cheese, would add force to the suggestions already previously elsewhere advanced, to supply these articles.

As regards salted meat, the constant use of such food must, as we have so often shown, act prejudicially, and it would thus destroy its own preventive powers by setting up catarrh. Hommel, however, urges, that during the prevalence of a cholera epidemic, salted food should be given, on the ground that the healthy stomach being stimulated by the salt, secretes always more hydrochloric acid, which acid kills the organism ; but we hold his premiss is wrong, and that so far from the stomach secreting more acid, its secretions lose their acidity from such irritating food. Laveran also advises against the use of salted provisions.

Marching out of Camp.—Notwithstanding all our precautions, a few cases may, from original importation, arise in camp. They should never, however, amount to an epidemic. The question of importation, however, brings up the question of marching out of camp to a new camp. The rule in cantonments in India now is that on a case of cholera occurring in any building occupied by European troops, such building should be immediately vacated, and the affected individuals placed separately from those among whom the disease has not yet appeared, either in a building or under canvas. If a second case occur among the particular body so moved, they must again be moved. If a third case occur among this particular body within one week from the occurrence of the first case, then the men composing it must be immediately moved from the station into camp. If several barracks are affected simultaneously, their inmates must be likewise moved out. As a rule, only such buildings are to be vacated as have actually presented cases.

Now, in warfare these conditions have to be modified. Cholera, when imported, should it go beyond a few cases, is not likely to restrict itself to a few tents, but will appear promiscuously throughout the camp. There will probably be but one water supply to the camp, and if the cases be numerous, the source of infection will undoubtedly be this. We have then to meet cholera under two aspects, first, where there are but few cases, and, secondly, where there are a great many. Under the first aspect there is no need to strike camp, the cases should be isolated half a mile or so from camp to leeward. But on more cases occurring, it would be best for the whole camp, and not simply that portion of it in which the cases have occurred, to move out. They should move out to a site already determined on, for the approach of cholera will have been always foreseen coming up through the lines of communication. We have already indicated the facts concerning camps. We have now only then to indicate those concerning marching out, and with this we shall include the subject of marches generally as regards cholera.

Marches generally.—All evidence shows that the state of body produced by long and fatiguing marching increases the predisposition to cholera. Balfour shows that, of the native army of Madras, the attacks of cholera in cantonment were 85, as compared to 200 during marching, in 10,000 strong. This ratio may not be, however, entirely due to the fact of mere marching, *per se*, for the marches may have led the men through infected districts. But Dr. Loriner has shown that the troops were more frequently attacked on long than on short marches, thus, the troops in 219 marches of 20 to 40 days were attacked 39 times, whilst in 14 marches of 100 to 120 days, they were attached 7 times; or, taking 100 marches as the basis, they were in the one case seized 18 times in 30 days, and, in the other, 14 times in 30 days. He also shows, in his tables, that the number of attacks of cholera occurring on the march increase regularly according to the number of miles and the number of days. The element of fatigue is certainly here the influence, for only very slightly are the officers, who are mounted, affected; whilst the cavalry suffer far less than the infantry.

Thus, then, as regards marching in cholera times, the marches must be so arranged that the men are not constantly fatigued, and regular halts must be arranged.

Marching out for Cholera.—We now come to marching out of camp on account of cholera actually having been imported into camp.

As we have said, a site should have been selected by the provident surgeon beforehand. This site should not be so far off as to enjoin a long and fatiguing march to reach it. A site recently used by another regiment for the same purpose should never be used. Dr. Rice has given an example of the danger of occupying an encamping ground recently used. Three cases (fatal) of cholera having occurred in a gang of coolies working on the road some thirty miles from Jubbulpore, the coolies fled to a place two miles off, and on four more fatal cases occurring, they disappeared altogether. Ten days after, a body of pilgrims from Nagpore encamped for a few hours at the latter spot to cook their food. They then moved on. Two days subsequently they were seized with cholera, nine cases occurring, three being fatal.

Before the date of marching out, let the camp be prepared ready to receive the men as far as possible, so that the tents may be pitched on arrival, and thus the men will not get chilled whilst waiting for them to come up. Again, after three cases have occurred, it is of great importance at once to march the whole camp out in the field, and not to temporize by marching only the affected portions. An example may be quoted from a British regiment in India, of which the right wing delayed to march out four days after the left wing had already set out. The left wing had three fresh cases on the march out, and then remained free. The right wing, on the contrary, had in the first three days of marching out, fifty-two cases, and the epidemic did not leave for another seventeen days. The conditions of an Indian prison

resemble, as regards the necessity of marching out, a camp. And the experience of the Agra prison in this respect is conclusive, for in three epidemics, before removal of the prisoners was practised, the admissions for cholera were 392.29, and the mortality 60.53 per 1000; whereas, in four epidemics, *after* removal was practised, the ratios were 68.99 and 17.02 per 1000.

Dr. Munro wisely has insisted on the men marching out in the early morning. They start thus refreshed by sleep, and the temperature rising as they proceed, there is less chance of chill. If, on the contrary, the men march out in the evening, he states that invariably a larger number of cases follow; moreover, the temperature gets gradually or suddenly lower, and chill is very liable. The exposure to the early morning sun is of far less danger than the exposure to chill at night. And even supposing that the men have to wait for their tents, chill is less liable to occur in the sun than in the falling evening temperature. Period for marching.

Before marching out, let the men have a good hot breakfast, and then fill their water-bottles with tea. On no account let the bheesties fill their mussacks at the abandoned camp, or let any water be taken from it as water (tea is protected by the tannin). The mussacks should be destroyed if there be a reserve in store; if not, let them be washed out with boiling water, and let no water be put in them till the troops have got well away from the old infected camp. Still better, in places where they can be employed, is the use of Norton's tubes, by which a water absolutely free from infection can be obtained. Having reached camp, let the men at once change their clothes. At the new camp, the rule of reducing fatigue and other duties as much as possible should be carried out. Let the regimental bands play, and enliven the men, and let amusements, such as gymkhanas, be started. A gymkhana was held weekly in the Kurram Valley during the outbreak of cholera there in 1879. The night duties especially are to be reduced as far as is possible with regard to military precautions. Procedure in the new camp.

The march should, of course, be at right angles to the general line of communication, or, rather, the new camp should be so placed. The immediate locale of the new camp should be changed, as far as the nature of the ground permits, regularly. This changing camp will employ the men, and will move them off to fresh ground. If, finally, it be determined to move some distance off the old camp, such as a march of two or three days, the troops should not be marched, if possible, along the banks of rivers, or camp *en route* in confined valleys. An illustration of this occurred to the French in Europe, the moral of which is equally applicable to hot climates. In the Dobrudscha expedition, in 1854, the French army was seized with cholera. The first division withdrew from Varna in very hot weather, and by long and exhausting marches. Instead of camping on high and dry land, they camped in a deep and marshy valley. Out of 10,590 men, this division lost, in four weeks, 2056, whilst the loss of the second and third divisions, who had not marched away from Varna, was far less. This shows,

then, that unless the march to the new camping ground be conducted according to the principles laid down, the result may be worse than if the men had remained in their original camp. The good effect of striking camp and marching off to a fresh site has been attested throughout the history of cholera. The great epidemic occurring in 1817 in the army of the Marquis of Hastings, in which such terrible mortality occurred, is a striking instance of the results of this measure. When the army had struck their original camp and marched to the dry and elevated plateau near Betwah, the disease ceased. And this end has been gained in countries outside India. In Algeria, for instance, in 1859, cholera attacked an expedition in the plain of Trigah. The virulence of the attack was great, but, on the force quitting Trigah for the plateau of Tafoughal, the cases immediately began to diminish, and, within a fortnight, ceased altogether.

If cannot move camp?

But it may happen that the military situation is such that camp cannot be changed; here, then, we must isolate the sick from the healthy, and forbid all intercourse with them. A fresh source for drinking-water should be found, and the precautions already indicated strenuously adhered to, whilst general sanitation of the camp is to be especially looked after by a medical officer whose sole duty is for this purpose. Neighbouring ground to windward can most probably, at any rate, be taken up. The mere change of a few hundred yards is better than no change.

Sulphur fires.

Sulphur fires of Dr. Tuson.

In such cases especially, and also in all camps in cases where cholera is spreading up the lines of communication, sulphur fires would seem to be indicated. Deputy Surgeon-General Tuson, in 1872, when sanitary officer at the Sonepore fair, during the height of the pilgrimage, when the people were there in thousands, caused sulphur fires to be lit in the camp 50 yards apart, and kept alight during the whole time that the fair was at its height. Epidemics of cholera had generally broken out previously, but not a case occurred in 1872. At Khargoul, in 1873, cholera broke out. Sulphur fires were burned all round the village and through the streets, and the epidemic subsided. Again, in the same year, the disease arose in three villages near Dinapore. The same measures were adopted, and cholera ceased almost immediately. Lastly, cholera became epidemic in Rampore. Sulphur fires were burnt, and the disease disappeared in three days. In his pamphlet on the subject, Dr. Tuson urges this procedure in all cases where epidemics are to be feared, or to prevent spread where cholera has actually been imported in any camp. The piles of wood should be placed around the camp at 40 or 50 yards interval, especially to windward, and should all be lighted simultaneously. The basis of his explanation is the germ theory of the disease. As we are bound to try every rational suggestion, we have alluded to this procedure.

Night Duties.—The men should be cautioned against exposure at night, and especially against leaving off their cholera belts, or coming out into the cooler night air without them, and so exposing the abdomen. The remarks already made on this

head concerning bowel complaints apply equally here. "The bed is a sleeping garment" (Pettenkofer); hence, be sure that this sleeping garment is kept scrupulously dry. The men's blankets, if damp, will lose all their protective power.

General Rules.—Besides the foregoing rules to be applied to each special condition of the environment, there are certain others which may now be mentioned. In the first place, the personal cleanliness of the men is a prime object; let there be bathing parades daily, but let these parades not be prolonged. Bathing parade.

Again, instruct the men in the foregoing rules about food, chill, and the like; at the slightest diarrhœa, let them be instructed to go to hospital for treatment in cholera times. Warn the men.

Daily parades should be held by the medical officers. All men complaining of diarrhœa or vomiting, of abdominal pain, or of pains in the limbs, should be sent to hospital for surveillance. The early discovery of diarrhœa is of immense importance, whether this diarrhœa be simple or specific. Whilst all ailments should receive especial attention in cholera times, even the slightest, diarrhœa is the especial form to be searched for and arrested. As a rule, each successive camp will have forewarnings, in the form of a disposition to stomachic and intestinal catarrh; everything that can cause such conditions must then be searched out and put aside. Parades.

It is also manifestly of great importance to discover as soon as possible whether the diarrhœa is specific. De Wouves and Mulhousen assert that such diarrhœa is always accompanied by albuminuria; this has been corroborated by Herman. Again, Koch has provided us with a means to determine this point; and the simple investigation required* to discover the characteristic organism could at any rate be carried on at the base. Examine stools.

A recent instance of the value of Koch's discovery shows how great is the efficacy of bacteriology in army diseases. An Italian emigrant steamer arrived at New York, on board of which a suspicious case of diarrhœa had occurred, but yet the symptoms were not perfectly conclusive of cholera. Cultivation tubes were inoculated with the dejecta; the cultures were characteristic of Koch's bacillus; the vessel was therefore kept under observation, and shortly after unmistakable cases of Asiatic cholera broke out.

Besides the foregoing heralds of an approach of cholera in the individual—the discovery of the organism rendering it certain—Dr. Poynanski has stated that during the prevalence of cholera the pulse in all men who are naturally predisposed becomes extremely low—45 or 42—even when they are apparently in perfect health, and that this lowering in cholera times may occur weeks before the onset, and may be considered as pathognomonic of the pre-

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* The investigator had only to warm the gelatine and to mix it with a flake of mucus from the dejecta, and to pour it on the object-glass. It was not necessary to have a special warming-apparatus for making the cultivations—the indoor temperature in summer was always sufficient. The slide was then put under a glass receiver, or, if this were not at hand, between two plates.

disposition to the disease. As the result of his researches he also states that cholera only attacks those who previously experienced this pulse diminution. We, ourselves, cannot say whether these data be true, but as every contribution may be of some use, the army surgeon should bear these in mind. Finally, Annesley lays stress on the fact that the countenance of a person in the premonitory stage is often pallid, anxious, and sorrowful. By thoroughly setting our house in order, and by attending to the susceptible element in camp, it is manifest we meet the onset of the disease half-way.

"Medicinal rations."

It would seem advisable that, in cholera times, the men should have a daily medicinal "ration," calculated to keep their digestion in order. We have seen the relation of the organism to acids; here theory conforms to practice, for it is manifest that by attending to, or preventing, gastric derangements, we fortify the inner man. We therefore would urge that every man should, twice daily, have a "ration" of hydrochloric and acetic acids. Surgeon-General Murray, of the Indian Medical Service, has published the effects of certain acids upon the forms of microscopic life found in the dejecta of cholera, and he found that they invariably were destroyed by acetic acid, whilst other acids did not possess this power. Such a ration of acids could do no harm, and whether their theoretical action be sound or not, would at any rate keep, as we have said, gastric derangements in check. Dr. Curtin extols sulphuric acid for a like purpose. Other means of augmenting the resisting power of the body have been suggested. In 1883 De Burq suggested small doses of copper as a prophylactic; all the French Commissioners tried it, but Dr. Thuillier of the Commission succumbed. Dr. Beaman also advocates the use of common salt in the same direction.

Conservancy.—We would again allude to the general conservancy of the camp. All the rules that have been laid down concerning this most important factor in other diseases are equally, if not more, imperative in cholera. No wonder that cholera is endemic in Bengal; it would indeed be surprising if it were not. In 1876, Macnamara wrote that there was no country in the world which more urgently demanded the aid of sanitary science than India, and "where so much had been written on sanitary improvements and so little done." That the same holds good of some parts of India in 1885, we have only to refer to the evidence taken before the Calcutta Sanitary Commission, and to the Honourable Justice Cunningham's memorandum published in the *Englishman* of December 13 and 16, 1884. "For hundreds of yards huge open cesspools lie seething and festering in the sun, filling the surrounding atmosphere with poisonous exhalation." Now the favouring soil offered by filth to cholera is shown by the experiments of Frankland, who found Koch's bacilli to grow very quickly in sewage. But although good sanitation is required, yet it must not therefore be laid down that the opposite condition, *per se*, will bring about cholera. In the parallel case of enteric fever, Dr. Budd showed how for years most unsanitary

conditions would exist, but yet enteric fever did not break out, until the specific poison from an enteric-fever patient was added. And so it is with cholera. For many years the cantonments of Upper India, in which our soldiers have been located, have been examples of cleanliness, yet they have suffered from cholera. Good conservancy will do much, but it will not do everything; whilst no amount of filth will produce cholera in the absence of the choleraic germ.

Treatment of patients in an outbreak.

I now come to the immediate treatment of patients to prevent them infecting others. The first case must, to begin with, be at once isolated, and all succeeding cases rigorously isolated from the rest of the camp. This isolation must also be extended to the sick attendants, the cooks, and all who are in attendance on the cholera camp. The hospital tents must be well to leeward; advantage should be taken of any natural isolated positions to locate them. The latrines for the patients must also be separate. Next to isolation, is disinfection. Disinfection must be applied to everything proceeding from, or in relation to, the patient. Thirdly, the hospital must be as "depopulated" as possible—that is to say, give each patient as much individual space as can be granted.

Disinfection.

A few preliminary remarks on disinfection in connection with cholera are necessary. In all works on cholera, solutions of the sulphates of iron, zinc, and copper are largely recommended. Now, we have before shown that their power is grossly overrated. Both theoretically and practically, they seem to be contra-indicated in cholera. These metallic sulphates have, it is true, a certain power of preventing putrefactive fermentation, but their power of destroying the growing power of the organisms of disease appears to be either *nil* or very limited. Thus, Sternberg has shown that a saturated solution of ferric sulphate failed to destroy the growing power of any of his test organisms, even though the time of exposure was two hours. Recent experiments on the micrococcus of pus gave similar results. Other observers have shown its feeble power against anthrax spores. Again, as regards zinc sulphate, Sternberg showed, in the same paper, that though less powerless than ferric sulphate, yet its potency was not great. A 20 per cent. solution was powerless against the pus micrococcus. Cupric sulphate, on the other hand, is far more powerful; it destroys the micrococcus of pus in the proportion of 0.5 per cent. (1 in 200). The conclusions of Dr. Sternberg are that cupric sulphate is safe for the disinfection of material not containing spores, but that none of the metallic sulphates can be relied upon for the destruction of spore-bearing organisms, whilst zinc and ferric sulphates are too feeble for any disinfecting purposes.

Again, not only would it seem that zinc and iron sulphates give negative results, but they also are of positive harm theoretically. For they have got a certain value in preventing putrefaction. But Koch has shown that the existence of putrefaction (in the laboratory) arrests the growth of the cholera organisms. On these grounds, therefore, we hold that both iron and zinc sulphates should no longer be used in cases of cholera. And though

sulphate of copper is more powerful, yet, as the question whether the cholera organism is spore-bearing is still *sub judice*, we would also reject this agent.

In cholera, as in other diseases, we strongly hold fast to corrosive sublimate.

Treatment of the stools.

The stools are the most important poison-bearers, if not actually the only poison-bearers. Their disinfectant treatment is therefore of supreme importance. Koch and Pettenkofer urge that they are poisonous directly they are passed, whilst Thiersch would hold that a certain change is necessary to occur in them before they attain their infective power. Be this as it may, it is our imperative duty to act on them at once. At the recent Sanitary Conference at Rome, Koch stated that from his recent experiments he was convinced that for disinfecting the excreta of cholera patients, corrosive sublimate was one of the most reliable agents, and could be safely recommended in the proportion of 5 per cent. He does not seem, however, to have urged its adoption. The use of carbolic acid was adopted instead. The following method should be pursued. The dejecta of the patient should be received into a vessel containing a 5 per cent. solution of corrosive sublimate. As soon as passed, some more of the solution should be poured off them. Similar is the proceeding if carbolic acid is used. According to the recommendation of the Rome Conference, the dejecta and also the vomit are to be mixed with a solution of carbolic acid and chloride of lime,* equal to the amount to be disinfected. The excreta thus disinfected should be at once removed to the trench. If possible, however, all excreta of cholera patients should be burnt. Prof. Du Chaumont's suggestion of petroleum, could it be carried out, would seem to be especially pertinent in cholera. M. Kaezko, remarking that hitherto cholera is unknown in Austrian Poland, lays stress on the petroleum emanations from the extensive petroleum mines in the district. In addition to this disposal of the fæces, we would at any rate burn sulphur fires in the neighbourhood of the latrines. For occasionally cholera may be communicated by pulverized particles of cholera dejecta through the air. Hence, every precaution to prevent this should be taken. Dr. Koch has shown how, at Alexandria, the sewage of the town fouled the sea-water close to the shore. A portion of this impure sea-water was continually being pulverized into the air, and might thus have been communicated to those who lived near the sewers, amongst whom indeed a large number of cases occurred.

Pettenkofer urges that the stools should be kept or rendered acid before disposal. The amount of disinfectant to be used should be such as will render them and keep them so till they are buried. Carbolic acid is the efficient remedy for this purpose. He holds, that the stools should always be tested to see that they are properly acidified by litmus paper. Whatever be the reagent

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* Strength: Carbolic acid 5 per cent., chloride of lime 4 per cent.

used, the dejecta should be left in the receptacle for at least ten minutes before throwing them into the trenches.

I have already alluded in the first part of the work to the general question of disinfection of the patient's clothes, blankets, tents, &c. In view of the extreme importance of the case in cholera, we will briefly particularize the matter with regard to this disease. Of clothes, &c.

In the first place let everything in the way of blankets, clothes, &c., belonging to the patient that can be spared be burnt. A mattress should especially be burnt, but these articles of course will only be found at the base.

Next, for disinfecting clothes and bedding (*i.e.*, blankets) that are not to be disposed of by burning, we would advise first of all boiling for one hour; (2) or soaking for two hours in corrosive sublimate solution;* or (3) immersion for twenty-four hours in a weak solution of carbolic acid and chloride of lime.† According to Dr. Koch, the mere act of drying them in the open air should disinfect them, but he advises also additional measures, such as the above. Clothes, bedding.

Washing the tents with (1) corrosive sublimate solution,‡ or (2) by the weak solution of carbolic acid and chloride of lime, is indicated. After this they should be well ventilated and, in addition, fumigated. We have already alluded to the contradictory statements concerning fumigation by sulphurous acid. In Afghanistan it certainly appeared to me to be successful, and I would again employ it. In the special medical service lately organized at New York to deal with cholera, "disinfecting squads" have been enrolled, whose agent is sulphur. Minute directions have been laid down concerning the process; and it would appear that for every cubic yard of space of any room, five drachms of flowers of sulphur are necessary.§ The sulphur is placed on an iron plate, some alcohol poured over it, and then lighted. The door of the tent must be kept closed, and the bedding and clothes of the patient, already previously disinfected, might, for additional precautions, be placed on the floor inside. Fumigation by acetic acid has also been advocated; also by chlorine gas. This latter form would not appear to be protective, for a case is given by Gunther of a fatal seizure of an employé in a chlorine chemical workshop, in which the whole premises were filled with the odour of chlorine. Lastly, nitrous acid fumigation,|| that has been so warmly advocated in yellow fever, is to be recommended here. Whatever the means for fumigation, the process should last three hours at least, after which the tent should be left exposed to the weather for ten days (Bengal Orders). Tents.

The bodies of those dead should be burnt; if not, they should be enveloped in a sheet saturated with either the corrosive The dead.

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* Strength: 4 oz. to 1 gallon of water.

† Strength: Carbolic acid 2 per cent., chloride of lime 1 per cent.

‡ Strength: 1 part in 1000.

§ 25 cubic yards require $1\frac{1}{4}$ lb. of sulphur.

|| Copper shaving $\frac{1}{2}$ oz., nitric acid $1\frac{1}{2}$ oz., water $1\frac{1}{2}$ oz.

sublimate solution, or the strong solution of carbolic acid and chloride of lime* of the Rome Conference. Such are the chief measures of disinfection.

Attendants.

We come lastly to the question of attendants on the sick and their protection. We have already alluded to the favourite statement concerning nurses on cholera patients in connection with the atmospheric, telluric, meteorological, and climatic origin of cholera. And we have already shown that with a proper recognition of the manner in which cholera is spread, it is quite true that nurses may not suffer more than others. But nevertheless there are exceptions, which exceptions have been passed over in silence by the new school. As a matter of fact very especial precautions are necessary for those attending the sick, not only for themselves, but also that they do not carry the disease elsewhere. And, moreover, in our campaigns the sick attendants have suffered severely as often as not. The test to show that hospital attendants suffer by reason of infection is stated by Dr. Cuningham to consist in their being attacked out of proportion to others. I accept that test, and now proceed to apply it, and show by examples that they do suffer by infection.

In Looshai.

In Egypt.

In the Looshai campaign, it is especially recorded that the sick attendants "were attacked in great numbers." For the cholera epidemic in Egypt in 1883, Surgeon-General Irvine, in his report, states that this epidemic did not bear out the assertion that attendants on cholera patients are not more liable to contract the disease than persons living otherwise, for the men of the Army Hospital Corps suffered out of all proportion to the other branches of the service. At the time of the outbreak the strength of the A.H.C. employed in the various hospital duties in the Cairo district was 102; of these, sixteen were seized and thirteen died. Probably not more than forty-five were in personal attendance on cholera patients; but nearly all those attacked had been in close contact with them. Dr. Klein, after his stay in India, speaking at the debate at the Royal Medical and Chirurgical Society, narrated "the well-known fact that the attendants on cholera patients, and all those that handle the evacuations, remained unaffected." But though this may be true with proper precautions, it is not true otherwise—indeed it would seem that such attendants run risk whether precautions are taken or not. Mr. Macnamara showed in answer how Klein had entirely overlooked such facts as had been collected by careful observers—De Renzy, Scriven, and others—and also had overlooked the fact that 700 men attending cholera patients in the epidemic in the North-West Provinces in 1867 contracted cholera. Again, in the epidemics at Dantsic in Europe, Prof. Leyden has drawn attention to similar facts. Griesinger's statistics for Moscow for 1830 show that the mortality amongst the hospital attendants was 30 to 40 per cent., whilst in the general population it was only 3 per cent. As the able reviewer of Dr. Cuningham's brochure on cholera

* Carbolic acid 2 per cent., chloride of lime 1 per cent.

states significantly, with regard to the statement "that of 10,599 attendants who waited upon 5696 cholera patients in military or gaol hospitals only 201 suffered," the fact is not noticed that in these institutions, acting upon the infectious hypothesis of the disease, every precaution is taken to prevent infection. Roth and Lex likewise have drawn attention to the variable results to hospital attendants; in some they have exhibited a remarkable freedom; in others the opposite—a strong death-rate; the conditions being in fact just the same as obtain in typhoid fever, and the cause of the variations lying in the varying opportunities for infection afforded by cleanliness, disinfection, or the reverse. Laveran again shows that in Toulon, in 1849, out of 179 hospital attendants, fifty-one died of cholera, or one in three, whilst in the garrison the mortality was as one to fifteen in those attacked. In Oran, 1865, the mortality in the hospital staff was 8 per 1000; but in the garrison only 1.66 per 1000. In 1865, at Toulon and Marseilles, the respective ratios of mortality were as follow:—in the 22nd Regiment, 31.75 per 1000; in the 28th Regiment, 29.8 per 1000; in the 38th Regiment, 19.33 per 1000; but in the hospital attendants, 38.60 per 1000. In a large airy hospital in India, it is not likely that the attendants should suffer; reverse the conditions, or let insanitation creep in, and they will suffer disproportionally; but to state that hospital attendants are no more liable to contract cholera than persons not brought in contact with such patients, and to state nothing more concerning this, is not in consonance with fairness of medical inquiry. Finally, recent events in Naples and Marseilles have, as a matter of fact, shown that under the unsavoury conditions there prevalent, greater risk is run by hospital attendants.

From the foregoing consideration, then, it behoves us to take especial precaution as regards the attendants. In 1886, in the Punjab, 700 men who attended the sick contracted cholera. They should have frequent intervals of off-duty. No man should be in attendance at a stretch longer than three hours. They should on no account either prepare or eat their food in the hospital. Before leaving the hospital they should invariably wash their hands and face with a weak carbolic-acid solution. After attending to a patient they should invariably wash. If their clothes become soiled, at once cleanse the spot with one of the before-mentioned solutions, and, finally, they should have a special suit to wear only in hospital.

Hospital tents.

Finally, acetic-acid fumigation has been found to be an agreeable and, at the same time, an antiseptic proceeding for the hospital. It can be easily carried out by a wood fire, over which a small pot of vinegar and water is placed, and the fumes thus dispersed; or with acetic acid, as detailed previously. If vinegar be used, 1 oz. with an equal quantity of water, followed in half an hour, by half the quantity, is sufficient.

Cholera in the Afghan war, 1879.

I come now to the cholera in the late Afghan war. Let me first allude to some facts attending the outbreak of cholera after the Hurdwar festival of 1867. The course of the epidemic in that

year did not stop at Peshawur, but crossed the frontier into Afghanistan; "in this latter country it broke out with fearful violence early in July, and continued until the month of September" (Macnamara). In 1879, the great twelfth-year festival at Hurdwar again came on. But in 1879 we were at war across the frontier in Afghanistan. Now, as we have seen, the Sanitary Commissioner with the Government of India in 1867 had drawn attention to the "very dangerous influence of the pilgrims" in the diffusion of cholera, and had suggested a measure of quarantine. There was also at hand, and distributed to every hospital in India, the treatise of Macnamara, giving proofs, convincing to most minds, that cholera is spread by human intercourse; and, moreover, containing a consideration of these pilgrimages as regards the prevention of their agency in communicating cholera. The course suggested by Macnamara of "a system of land quarantine applied to pilgrims, who should be stopped on the line of march if cholera broke out, and kept in quarantine," was written fair and large. The fair, however, was held. The conditions of Hurdwar and the measures that were taken have been aptly described at the meeting of the British Medical Association at Cardiff in 1885 by Surgeon-Major Pringle, late Sanitary Department of the Indian Army, a man of unrivalled practical experience in cholera, having had personal connection with cholera outbreaks for twenty years, including the epidemics of Juggernath in 1856 and of Hurdwar in 1867 and 1879. He showed how Hurdwar was incapable of being placed in such a sanitary condition as to resist, under certain conditions of overcrowding, an outbreak of cholera. "Nevertheless, annually, at the worst season of the year for cholera epidemics—namely, April, and every twelfth year—to an appallingly increased extent, the collection of pilgrims is encouraged in every possible way, even though cholera be visibly in their midst, as it was in 1867 and 1879. All laws of sanitation were grossly violated at Hurdwar in 1879." And, again, he states, "Every rule of sanitation was violated by a neglect which actually amounted to an ignoring of the melancholy experiences of 1867." What was the result? When these conditions—cholera in the midst of the pilgrims, overcrowding and insanitation—were at their height on the great day of the festival, "cholera burst out like a long pent-up fire," and was carried away by the stream of departing pilgrims to our north-western frontier, and thence to Afghanistan. But now, unfortunately, our soldiers were at war in Afghanistan. Camp by camp the disease invaded the Khyber, Kurram, and Candahar columns. The details of the outbreak in the three columns are as follow:—

A. In the British Troops.—In the Peshawur column there were 358 cases, with a mortality of 74 per mille; in the Kurram Valley, 24 cases, of which 21 died; in S. Afghanistan, 94 cases with 83 deaths.

B. In the Native Troops.—Out of 203 deaths, 75 occurred in the Peshawur column, 21 in the Kurram, and 107 in S. Afghanistan.

As regards the months in which the cases occurred, in the British troops in the Peshawur column, 38 cases were in May, 284 in June, 32 in July, 4 in October; in the Kurram Valley, 9 in July, 12 in August, 1 in September, 12 in October; in S. Afghanistan, 1 in June, 52 in July, 41 in August. Thus, in the Kurram and Candahar columns, the outbreak occurred about a month later than on the Khyber side. The case occurring in June in S. Afghanistan may be reckoned with the July cases, as it occurred at the end of the month.

Now, in reviewing these figures, one fact stands prominently forward—namely, that in the Khyber line, there was nearly an eight-fold increase of cases in June over those of the preceding month. In neither the Kurram nor Candahar column is there this remarkable increase of cases in any one month over another. Is there any reason for this? There is.

Let me quote again from Surgeon-Major Pringle. "From this intensely cholerized centre (Hurdwar), the outcome of the gathering of literally hundreds of thousands of pilgrims, with cholera proved to be in their midst, resulted, what was known among the troops returning from the last Afghan war, as 'the march of death.' Another proof of the penalty demanded for the violation of all sanitary laws and sanitation." The Peace of Gundamack had been signed, and Government wished to withdraw troops from the Khyber line. But cholera was advancing up the Pass. Most of the troops at this time were encamped on spurs above the plain and were in good health. By remaining it was held that they would become exposed to the "atmospheric wave," whereas by returning they would march away from it. By remaining it was held they would be attacked in greater numbers. The withdrawal, therefore, took place in June, and the march of death resulted. "The choice was a choice of evils, and great as the loss was, there seemed every reason to believe that it would have been equally great, perhaps greater, had the troops remained where they were." But I venture to submit that the statistics of the disease in the other columns are not favourable to this opinion advanced by the Sanitary Commissioner with the Government in India. In the Kurram Valley no month stands out preponderating in cholera mortality, there being only 9 cases in the British troops in the first month and 12 cases in the second. In the Candahar column, counting the case at the end of June with those of July, there was a decrease of 12 cases in the second month. In the Kurram Valley, the troops moved out on to the surrounding spurs in most instances, and the result showed that, granting they were penetrated by an "atmospheric wave," the mortality was practically unaltered—nay, even in some regiments which lay more in the course of this wave in the plain, there was no increase of mortality at all.

Case of 23rd Pioneers.

The experience of my regiment may now be related. In the Kurram Valley most of the regiments moved off to the surrounding spurs. The head-quarters wing of my regiment had already for some time previously been encamped in a high gorge leading

out of the plain at right angles to it, at a height of over 8000 feet. The remainder of the regiment lay in the plain some eight miles distant, on the line of communication. Seven days before the first case of cholera, four cases of diarrhœa presented themselves for admission; on the following day, 28 fresh cases came in. About one mile or so from the wing in the plain was a large native village, in which cholera was at this time raging. On the appearance of these cases of diarrhœa, I recommended that the wing in which they had all occurred—viz., that in the plain—should be moved off to head-quarters up the gorge. This, however, could not be carried out. Intercourse with the village had been previously strictly forbidden, and renewed instructions were given. As the camp could not be moved up to the gorge, ground was taken afresh in the plain. The greatest attention was directed to the water-supply, and it was hoped that by these means cholera might be prevented from seizing the camp in the plain. I was at that time camped up the gorge, and had to ride to the plain to visit the hospital there. Eight days after seeing these diarrhœa cases, I was called up early one morning by the hospital assistant to see a case of cholera. I found the man violently purged with a rice-water stool. The attack had seized him so suddenly that he had not had time to go to the trenches, but had passed the stool just outside the tent. He was also retching and vomiting. The dejecta were at once scraped up from the ground and burnt, and the soil on which they had fallen sprinkled with disinfectants. The patient was immediately isolated on a hill, half a mile lower down the gorge, and passed successfully through a typical attack of cholera. On inquiring into the history of the soldier who had been seized, most instructive evidence was ascertained. He had only two days previously been transferred from the wing in the plain to the wing in the gorge; on following up the history by inquiry in the camp in the plain, it was found out that three days previously he had disobeyed orders, and gone out to the native village, remaining there some time. Doubtless he became infected there. The treatment consisted in perfect isolation, sulphur was kept burning in the hospital tent, the stools were buried (disinfected) far away from the water-supply, and the man recovered. No more cases occurred in this camp. But a few days subsequently a second case occurred in the wing in the plain; the same principles of isolation to leeward, and of disinfection were applied. The most ample precautions as to food, reporting for diarrhœa, and conservancy were entailed, and the men were satisfactorily stopped from any further intercourse with the village.

Now here we maintain we had a crucial instance of the carriage of cholera by human intercourse. If the first man did not get infected in the plain, and if the gradual invasion seriatim of camp after camp were due to an atmospheric wave, then we must suppose that, in this particular instance, the wave took a small journey at right angles to its course, and picked out this one man, and then went back again out of the gorge without infecting any others.

Again, as soon as the other camps had moved away to the surrounding hills, they began to improve; the principles of isolation were fully carried out, the sick being located on separate knolls where possible.

As regards the immediate agent by which human intercourse acted in Afghanistan, it was doubtless through the drinking-water. Surgeon-General De Renzy has placed on record that "in the late Afghan campaign the water-supply arrangements could hardly have been worse if they had been specially designed to favour the propagation of a water-borne disease, and to that, and that alone, the terrible losses of the troops from cholera are attributable."

One final incident connected with the Afghan war is worth recording. In the second year of the war the 15th Hussars returned from South Afghanistan in April 1879. They left Shershah, near Mooltan, on the 23rd of April by train, travelling on the 24th and 25th, when they reached their destination at Meerut. There was as yet, at this time, no cholera in Afghanistan, and no cholera at Shershah. Case of 15th Hussars.

At Meerut, cholera had broken out in the bazaars four days after the great bathing day at Hurdwar, namely, on the 16th of April, and cases had occurred up to the 5th of May. Now, three days after leaving the train, or on the 28th of April, 3 cases of cholera occurred in the Hussars. In all, subsequently 11 men were seized up to the 6th of May, of whom 9 died.

On inquiry it was found that out of 27 men of B troop who travelled in a certain third-class carriage, 7 had cholera and 6 diarrhœa; in all, 13 men out of 27, who had journeyed in this carriage, were affected. Again, out of the total 11 cases, 10 came from B troop, of whom 7 travelled in the carriage in question.

These circumstances were so striking, that an inquiry was instituted as to the history of the carriage, with the following result:—The carriage left Ghazeeabad (Delhi) on April 14, at 5 A.M., attached to the up-country train, and was used for the conveyance of passengers: these may or may not have been pilgrims, but it is extremely likely they were so, as a great number were returning from Hurdwar at the time. The carriage remained at Lahore from the morning of the 15th of April to the evening of the 21st, when it was sent to Mooltan. At Lahore it had remained unused, and remained so until it reached Shershah on the 23rd of April, on which date the 27 men of B troop started in it back to Meerut. All the carriages were washed and fumigated with sulphur before use by the Hussars.

Deputy Surgeon-General Marston, from whose report in the A.M.D. Reports for 1875 I have taken these facts, says that it may be fairly assumed that any third-class carriage travelling on the Sind, Punjab, and Delhi line, on or about the 15th of April, was occupied by cholera-stricken pilgrims. For it was not until the 22nd of April that all the pilgrims were disposed of, as not more than 6000 out of the total of 80,000 could be dismissed

daily. In fact, seventeen hours after this carriage had passed through Umballa, a case died in another train.

To our mind, the connection is evident. Dr. Marston's evidence is especially valuable in this instance, as being that of an authority who inclined to the views of Dr. Cuningham at that time. I therefore quote Dr. Marston's conclusion from this case, which is as follows:—"We are not warranted, as a matter of scientific judgment and logical deduction, in dogmatically asserting that cholera is never infectious, in fact, in the present state of our knowledge, it would be criminal to ignore reasonable precautions in this respect." It is, however, but fair to state that a different judgment was given by Dr. Cuningham in his Sixteenth Annual Report, for 1879. Therein he disputes altogether the decision above given, first, on the ground that an interval of seven days occurred between the first and last attacks in the Hussars; and secondly, on the ground that there is no proof that the carriage was ever occupied by pilgrims. Of the first objection, it is difficult to see the force, and to the second, I oppose Dr. Marston's "fair assumption," for pilgrims, as we have seen, were leaving at the rate of 6000 a day.

We have now come to the conclusion of the consideration of the principles which should guide the practice of prevention in cholera. The evidence is irresistible. Moreover, if our theory be wrong, the practice of which it is the fruit can do no possible harm; whereas, if the "nihilistic theory" be erroneous, how great must be the catastrophe resulting from it. It is, however, difficult to suppose that the united intelligence of nearly all Indian sanitary authorities, as we have previously shown, embracing the experience gathered from the whole of India, can be wrong; that the united intelligence of Germany can be little better than foolishness; and that the united intelligence of English authorities rests but on "one-sided anecdotes." It may therefore be assumed, as an axiom, that cholera does spread by human intercourse. And this, then, is the broad principle that must guide our action in tropical campaigns.

Radical Prevention.—But in the prevention of cholera in tropical campaigns it is necessary to strike at the root of the disease; and, in this matter, the whole subject is comprised in striking at the birthplace of cholera. This birthplace is in India, and from India it is propagated by human intercourse. The importance of recognizing the truth of this generally accepted dictum is evident. The theory that cholera nostras and cholera Asiatica are one and the same disease is beyond the pale of rational argument. I come, then, to the climatic theory. It is evident that, if cholera arise from certain climatic causes, we can do nothing. For, in the first place, these climatic causes are unknown; secondly, when found, we could not change or obliterate them; and thirdly, as we have seen, every condition of climate has been found to be associated with climate. With regard to conservancy and general sanitary arrangements, these, of course, when good, are of importance; but, as Surgeon-General

Furnell pithily observes, they will not ward off cholera any more than they will set a broken leg. But will the theory that is nearly universally held—viz., that cholera is propagated in some manner by human intercourse—help us? Dr. Cuningham, it is true, in the "practical conclusions" in his final work on cholera, states that "there is abundant evidence to show that isolation of the sick and disinfection of the discharges are valueless." I must confess that, although I have studied extensively the history of cholera, I have not come across "abundant evidence" of this kind. But turning to the testimony of men who have spent their lives amidst the disease, we find a totally opposite conclusion; and the authorities of the highest standard agree in stating that, under arrangements based on the recognition of the factor of human intercourse, the disease may be eradicated. It is well, therefore, to place on record their opinions. They all insist on the condition of the drinking-water. The late Professor Parkes, (Parkes.) in his paper on "The Water Carriage of Cholera," in the A.M.D. Reports for 1872, states that, if there were no opportunity offered for the contamination of the drinking-water by cholera excreta, "the investigation of cholera would come to an end from lack of material." Surgeon-General De Renzy has shown how (De Renzy.) cholera epidemics have become extinct in Fort William, Calcutta, on the introduction of a pure water-supply. Surgeon-General (Furnell.) Furnell holds, as surely as he holds any opinion, "that a pure and uncontaminated water-supply would practically abolish the enormous mortality of cholera epidemics," and that "there is ample proof that a pure and uncontaminated water-supply protects people from the ravages of cholera." Mr. Macnamara (Macnamara.) states that, "if we can only preserve the drinking-water from contamination, it is out of the question that cholera should become epidemic in either country or town." Professor Du (Du Chaumont.) Chaumont also, with reference to this question, holds "that it is not chimerical to believe that a time will come when cholera will be merely an historical curiosity."

The deliberate opinions of all these authorities are not to be lightly thrown aside, for they are shown to be true by the results already enumerated in the foregoing portions of this chapter. It is well known that disease introduced by the medium of drinking-water ever assumes epidemic proportions. That, in India, such opportunities exist for propagating cholera, is patent to the eyes of all who look at the question with unprejudiced minds. The same tank in a village will serve at all times, including cholera times, for ablution of clothes and bodies, and for drinking-water. "Tank banks in the wet, and the beds of rivers in the dry, weather, are resorted to for purposes of nature by people of all classes." Dr. Furnell has seen "the intelligent Brahmin, the ignorant pariah, the Government official, and the poor coolie, all defæcating on the banks and the beds of the tanks which supplied their reservoirs with water." The wells have, in a large number of cases, no parapet walls; here the clothes and bodies of the men are washed, and the impurities arising from the latter carried back to the

wells. Imagine the result in villages where cholera is prevalent; the water thus poisoned is drank by thousands. Such is the state of affairs, and from the consequences thereof a remedy is at once apparent. Regulations should be in force throughout India to prevent the pollution of the drinking-water by intestinal discharges. As at Guntur, in Madras, peons should be appointed to keep the inhabitants from polluting the wells and tanks either by washing their clothes or bodies, or by resorting to their neighbourhood for purposes of nature. Surgeon-General Furnell, in 1884, in his report to Government on the cholera in the Tanjore district, urged that a deep well be sunk in the villages, properly made of brickwork and masonry, with parapet and sloping sides; and that, in the larger villages, a pump should be constructed to raise the water from such wells into reservoirs, from which it might be drawn by stopcocks. This would keep off all defilement by dirty ropes and vessels, &c.

I firmly hold that, if the drinking-water be kept unpolluted with cholera discharges, no epidemics of cholera will arise. To keep drinking-water thus protected, a further safeguard is, however, necessary. Cholera patients must be kept away from it, as we have seen; but in certain instances this is especially urgent. The numerous sacred festivals and pilgrimages have ever been a source of epidemics. If, as we have seen, Government felt it imperative to stop the annual pilgrimage to Mahadeo's Cave, and if the prohibition of the pilgrimage was followed by a cessation of the epidemics, surely it is reasonable that a like course should be pursued in other cases. Dr. Cayley well observes, with reference to the epidemics in Odessa, as follows:—"The principle of non-interference with the customs and prejudices of the people is of less importance than the checking or mitigating so terrible a scourge as cholera, and the first really effectual measure towards that end must be to put an absolute veto on large pilgrim gatherings." These pilgrimages should be stopped. Had such a measure been ordered in 1879, our troops in Afghanistan would not have suffered from cholera. But although such a measure is dictated by reason, it is doubtful if it will be carried out. In that case the only resource left is a system of land quarantine as urged by Surgeon-General John Murray, formerly head of the Indian Medical Service: "The pilgrims should be stopped on the line of march if cholera occurs among them, and kept in quarantine, they and all their belongings undergoing a thorough ablution and fumigation before being allowed to pass on." That quarantine can be effectual we have already shown by the immunity of the hill tribes in Lower Bengal, by the immunity of Cuttack in the Odessa epidemics, by the case of the epidemic in Aliwah. Other instances can be cited; for instance, in 1886, the army of Paraguay, engaged in watching the forces of Brazil and the Argentine Republic, became affected with cholera. The disease was then communicated by the army of Paraguay to that of the Confederate forces. In the autumn it was carried by vessels from the camp to Corrientes and places in the neighbour-

hood of that town, but its extension to Monte Video and Buenos Ayres was checked by the strict quarantine rules which those seaports enforced.

Thus, by stopping fairs and pilgrimages, and by securing a pure drinking-water, we should hold our north-west frontier free from cholera, and by securing a pure drinking-water, we should cause the same end for our north-east frontier. And in this manner we should keep our military bases pure and undefiled.

CHAPTER XVI.

SMALL-POX.—TETANUS.—VENEREAL DISEASES.

Besides the foregoing diseases, of which we have fully treated, of course any disease of temperate climates can attack our troops. There are also other diseases of tropical climates that may affect us, but, so far as can be gathered from the history of our wars, we have not met them.

Ashanti, 1873.

Small-pox.—Small-pox has not been an infrequent visitor. Thus, in the Ashanti war of 1873, our troops were exposed to it. It had already been raging at Cape Coast for eight months, and in August (preceding Sir Garnet Wolseley's arrival) over 200 natives were treated in the Colonial Small-pox Hospital, whilst many were laid up at home, and many were to be found perambulating the streets with crusts on their face. Now the social relations between the men of the West India Regiment and the natives were unrestrained, and yet it was not until after eight months' intercourse that in August *one* case occurred. A second case did not occur until five months after. These two cases were the only cases.

Now the reason of there being no spread was, not because small-pox is not propagated by human intercourse, but because all the men had been not only vaccinated and re-vaccinated, but had also been extremely well vaccinated in their youth. As a consequence we had an immunity of nearly 700 men who were mixing freely with an infected community.

The measures to be adopted are obvious. Small-pox is well known to affect the west coast of Africa. Provision must therefore be made to meet it. Vaccinate all the force, and take a large quantity of vaccine lymph in the stores. Such should be the measures generally when warring against native tribes, for mostly such tribes are more or less affected.

In the preparations for the Ashanti war vaccine lymph was supplied in plenty.

China, 1860.

In the China war, small-pox threatened the force encamped at Tientsin, but was kept away from the camp.

Abyssinia, 1867.

In the Abyssinian war, as a safeguard against possible infection, the authorities of the 12th Bengal Cavalry wisely caused every fighting man, or camp follower, that had not been previously vaccinated or inoculated, or protected by an attack, to be vaccinated.

Sunjhie-ujong, 1874.

In the Sunjhie-ujong expedition, precautions had also to be taken, for small-pox was extremely prevalent amongst the Malays,

whole households being carried off. This, however, is not the case within our own Malacca territory, for here we have introduced vaccination.

In the Soudan in 1884, just before the expedition started from Suakim, a case of small-pox was landed from the s.s. *Neera*. It was isolated on an adjoining island. Another case was reported from the Gordon Highlanders on board the *Thibet*. The regiment was at once landed, and the case left on board. A third case two days after occurred on a third vessel. The two latter cases were then landed and put on a spit of ground to leeward of the camp. E. Soudan, 1884.

In the Nile expedition there were forty-one cases with five deaths. The disease was very prevalent at several stations in the native community. At Dal, in December 1884, thirty-nine cases among natives were admitted in one week. Nile expedition, 1883–4.

Small-pox is also very prevalent in Persia. Any military operations in that country should entail, therefore, due provision to meet it.

Re-vaccination.—Now the great preventive against mortality from small-pox is compulsory re-vaccination. All recruits on enlistment should be re-vaccinated, whether they have good marks of previous vaccination or not. The evidence of the German Vaccination Commission on this point is conclusive. In 1874 a fresh vaccination law came into force in Germany, making re-vaccination compulsory. This is the case in no other country in Europe. In 1884 the conclusion of the Commission on the results of this measure were published. They are as follows:—

(1.) Not a single death from small-pox has occurred in the German army since 1874, whilst both the French and Austrian armies, in which countries re-vaccination is not compulsory, show a very high small-pox mortality.

(2.) From 1875 a lower small-pox death-rate has resulted, lower than any during this century. Thus, whilst up to 1873, the small-pox mortality per 100,000 had only on six occasions in fifty-seven years been as low as ten or near it, and was usually fifteen to twenty yearly, nearer the latter than the former, after the law of 1874 it has varied between 3.6 per 100,000 and 0.3 per 100,000. That this is due to the law of 1874, is shown by the comparative mortality in Austria, where there is no such law. Thus the mortality rates are as follows in Germany and Austria. Previous to 1874 they were much alike. Since 1874 they have been—

	In Germany.	In Austria.
1875	3.6	57.7 per 100,000
1876	3.1	39.2 ,,
1877	0.3	53.7 ,,
1878	0.7	60.6 ,,
1879	1.2	50.8 ,,
1880	2.6	64.3 ,,
1881	3.6	82.6 ,,

(3.) Both German and other cities suffered severely from small-pox epidemic in the beginning of the last decade. But whilst in all cities, except those of Germany, the death-rate from small-pox,

after a temporary decline, has again reached a considerable height, in the German cities it has remained persistently low.

(4.) Before the law of 1874, re-vaccination had been practised considerably in the German army. This had not been the case in the French and Austrian armies. Now these armies suffered greatly from the epidemic of 1870–1, but in the Franco-German war the German army, though coming in contact in France with a population greatly affected with small-pox, yet suffered by far the least.

TETANUS.

Tetanus is also extremely liable to occur in hot climates under two conditions—viz., *overcrowding* and *insufficient food.* The prevention is obvious.

VENEREAL DISEASES.

On service the strictest precautions should be carried out to prevent the men consorting with the native women. These are invariably badly diseased. Opportunities of studying the disease in the Afghan war were not wanting.

Apart from this, however, in peace time the State should do all in its power to prevent infection. Syphilis invariably aggravates not only many tropical diseases, but also the actual predisposition thereto. Hence, all rational means should be taken to prevent infection in cantonments. Now, in 1884, a disastrous experiment was made by Lord Ripon in India in closing several lock hospitals in Bengal. The result was an enormous increase of disease. In the Report for 1885 of the Sanitary Commissioner with the Government of India, page 37, it is stated that "all three forms of venereal disease gave rise to much higher rates than those which prevailed during the last decade." Primary syphilis gave rise to an enormously increased proportion of admissions—namely, to 129 per mille against 87 or 88 in each of the three preceding years. The admission-rate for gonorrhœa increased from 147 to 171, and that for secondary syphilis from 25 to 32. The following table is given showing this increase of syphilis clearly:—

Army of Bengal.

	Admissions from Syphilis per Mille.			Admissions from Syphilis per Mille.	
	Primary.	Secondary.		Primary.	Secondary.
1870	...	24	1878	96	22
1871	73	24	1879	62	24
1872	62	23	1880	83	23
1873	49	18	1881	96	23
1874	66	23	1882	87	22
1875	71	21	1883	88	25
1876	60	21	1884	87	25
1877	56	22	1885	129	32

But this increase is still more apparent, if we examine the statistics in some of the stations in which the lock hospitals were closed. In

the North-West Provinces the lock hospitals at Cawnpore, Allahabad, Meerut, and Chakrata were abolished, with the following results :—In 1885 the ratio of hospital admission at Cawnpore rose from 166 to 309 per 1000; at Allahabad, from 260 to 850 per 1000; at Meerut, from 328 to 472; at Chakrata, from 123 to 244. But not only did the admission-rate increase in these four stations, but also in all the neighbouring cantonments, a result due, as shown by Brigade-Surgeon Hamilton, to the migration of the diseased women who infected the men, and through the men the registered women in protected places. Thus, in Agra, the rate per 1000 of admissions rose from 223 to 416; in Bareilly, from 228 to 485; in Moradabad, from 491 to 972; in Naini Tal, from 193 to 304. In his annual report the Sanitary Commissioner of the North-West Provinces states that "the figures are such as have never before fallen to my lot to record in all this series of twelve reports. As regards the garrison generally, they witness to the unprecedented ratio of 346.3 admissions per 1000, for comparison with 224.9 in 1884. As regards the garrisons of the four stations of abolished management, they witness to a mean admission ratio of 468.4, for comparison with 218.8 in 1884. Viewed in any possible light, the figures present proof of most unsatisfactory result." The results in the Punjab gave the same enormous increase of admissions. This experience continued in the same proportion until in 1887 the lock hospitals were re-opened, as it was felt that any further results of the experimental measure were undesirable. It is to be sincerely hoped that such a measure may never again be instituted.

CHAPTER XVII.

ANIMAL PARASITES.

We have finally to consider the prevention of animal parasites. In our wars in North Egypt and South Africa, in our wars on the Gold Coast, and amongst the hill tribes of India, we have met many and varied parasites. The following list embraces the most important members of the animal creation to be prepared for:—

A. *Cestodes:*
  The tæniæ.
B. *Trematodes:*
  Distoma hæmatobium.
C. *Nematodes:*
  Ascaris.
  Trichina spiralis.
  Dochmius duodenalis.
  Filaria sanguinis hominis.
  Filaria medinensis.
  Chiga.
D. *Annelida:*
  Hirudo tazalla.
E. *Insecta:*
  The pipsee fly (not a parasite).

Tæniæ.

Tapeworms.—The tænia mediocanellata is the variety principally met with. The tapeworm is a parasite which the British soldier is often in danger of harbouring. In Abyssinia it is very prevalent amongst the inhabitants, owing to their looking upon raw beef as an exquisite delicacy. In connection with the war in that country, it was found that all the European prisoners who indulged in raw beef suffered from tænia. The cases in the invading force were not numerous, and it is stated that they might have had an Indian origin, for no ova were detected in the beef obtained in Abyssinia, whilst they were said to have been so detected in the ration beef supplied from India. A liberal supply of male fern was sent out with this expedition.

In South Africa, especially at the Cape, this form of tænia occurs. Every second person in South Africa has been said to have it. Our men had especial precautions issued to them in this respect. Hirsch states that tapeworm infected the Hottentots who had served in the war in Kaffirland.

This form of tænia also occurs in Egypt and Algiers and along the West Coast of Africa. The natives in Senegambia are very

fond, being Mahomedans, of raw beef. The cattle are evidently the source of the disease in Algeria. Boudin has shown that during the years 1840–8 sixty cases occurred in a strength of 100,000 men, whilst in France, during the same years, there were only seven cases among 250,000 men; but since Algerian cattle have been imported, the parasite has become much more frequent in France.

In India the regiments in the Punjab are prone to it. In 1866 tapeworm occurred in the meat ration of the troops at Rawal Pindi. The fact that Punjab regiments would be the first to cross the frontier renders this important, for the Punjab would seem to be the part of India especially affected.

The tænia solium is less frequently met with, but it is to be borne in mind in cases where pork rations are given out.

In the matter of prevention, the rations must be thoroughly cooked. Never let the rations be underdone. Again, the men should be warned never to eat the internal organs of animals—*e.g.*, the liver, kidneys, &c. Again, never take water from a pond. Water from a pool contaminated with the droppings of animals constitutes one of the ways of entrance. In this respect in South Africa arrangements for collecting rain-water as much as possible were advised: some such devices as a rude funnel could be easily fashioned to collect the water.

It would also seem advisable never to issue preserved pork or any pork ration to the troops. Pork is not a good form of nutriment. Fresh pork in the countries we are called to serve in is liable to be the seat of parasites, and no one can tell what kind of pork has been preserved.

Distoma Hæmatobium.—The distoma hæmatobium is also a parasite with which we are likely to meet. It is endemic in Egypt and the Cape of Good Hope. In the operation of war in Egypt in 1882 our medical officers were cautioned concerning its occurrence. In Egypt it seems to be limited to the banks of the Nile within the Delta. Griesinger found it in 117 out of 363 bodies; Sonsino, in 13 out of 31 bodies. At the Cape it is also equally frequent, and here also it limits itself to the coast and the banks of a few streams. Our troops passed through or were located in the principal seats it affects—*e.g.*, King William's Town; East London, in Caffraria; the country from Natal to Pietermaritzburg, &c. Distoma hæmatobium.

It has been hitherto held that the parasite enters the body by the drinking-water, and that it inhabits the blood-vessels of its host, chiefly the portal, splenic, and mesenteric veins, and those of the rectum and bladder. The ova were held to enter the body by the drinking-water directly, or after adhesion to small plants, or certain fishes.

Dr. Allen, of Pietermaritzburg, has recently, however, pointed out that this view is not consistent with facts. He shows that the hæmaturia is practically confined to those that bathe, and especially to boys. The drinking-water may be taken from an infected stream, yet the drinkers generally are not affected, but Dr. Allen's researches.

those that bathe as well as drink. If the parasite lived in the vascular system, inasmuch as its power of laying eggs is enormous, the veins should become obstructed, as the ova are ten times the size of a blood-corpuscle, whilst the ciliated embryo produced is still larger. Moreover, Dr. Allen has never observed any disorders of the alimentary canal in these cases. Accordingly, he holds that the entrance of the parasite is by the urethra. The parasites, disturbed from the mud by bathing, swarm in the water, and enter the sac of the prepuce, and thence the unprotected orifice of the urethra.

Harley also asserts that the ova can enter the body through the skin.

Season.—Griesinger points out that the chief months in which the parasite may be expected are June, July, and August.

In the *preventive treatment,* on the view that the ova enter the body by the drinking-water, Dr. Sonsino states that "the true prophylaxis is to drink only well-filtered water." This should therefore be especially carried out in Egypt and South Africa. On the other view, that the urethra is the site of entrance, the men should be cautioned against bathing in muddy shallow pools in the affected regions. In boys in civil life, Allen urges that circumcision be carried out.

Ascarides.

Ascarides.—The lumbricus, oxyuris vermicularis, and tricocephalus dispar are enormously prevalent in tropical and subtropical regions. Our medical officers were warned of this in the scheme of diseases to be apprehended in Egypt in 1882. Tricocephalus dispar has been also asserted by Erni to be the cause of beri-beri. Our native soldiers are more predisposed to these parasites than the European, due probably to their mode of life. These parasites reach the human organism either directly by the embryoes from the human intestine, or, in the case of the lumbricus, by transmission through an intermediate host. Improperly cooked or raw vegetables and water are the vehicles by which they directly reach man from outside.

The *preventive treatment,* as regards vegetables, is to abstain from raw vegetables; as regards water, to filter it.

Trichina Spiralis.—The possibility of meeting this parasite in infected meat was pointed out in Egypt in 1882. From Hirsch's researches it would seem to be somewhat rare in the tropics. He finds very few references to the disease in Asia and Africa. A severe epidemic was reported by Wortabet in Syria, from eating the flesh of a boar.

In *prevention,* avoid all pork rations which present the characteristic appearance of this disease. The flesh presents naked-eye appearances sufficiently to arouse suspicion. All pork rations, apparently sound, must be completely cooked. Smoked hams and German-sausage meat are especially dangerous. Considering how extensive the disease is in Germany, we would strongly deprecate any of the concentrated German army foods, containing pork, being served out to an army, for instance, the German pea-sausage. Erbswurst, having much the same composition as the

pea sausage, was served out in the modified ration in Egypt in 1882. All such foods, however, coming from Germany, are not to be recommended.

It would be advisable, as before stated, on other accounts, never to issue pork on a campaign. Salting, as pointed out by Cobbold, is not fatal to the capsuled trichina. Complete cooking will remove all danger, as the trichinæ are killed by a temperature of 170° F.

Dochmius Duodenalis.—On account of the serious and fatal form of anæmia induced by the dochmius duodenalis, and on account of its great prevalence in Egypt, the prevention of infection was of much importance to us in Egypt. The anæmia induced by the disease was so distinct and so often fatal as to have earned an especial name—Egyptian chlorosis or tropical chlorosis. The Egyptian soldiers suffer much from it. Dochmius duodenalis.

These cases of "Egyptian chlorosis" would seem to be identical with one form of the disease beri-beri. Dr. Kynsey, the principal medical officer and Inspector-General of Civil Hospitals, Ceylon, has lately presented an interesting report on anæmia or beri-beri of Ceylon, in which he maintains that one form of the disease depends on the presence in the alimentary canal of parasites, principally of the anchylostoma duodenale, and possibly of the tricocephalus dispar, causing a form of anæmia the result of loss of blood. Wucherer and Da Silva Lima have also found small worms resembling anchylostoma duodenale in persons dying of the disease in Brazil. Stammeshaus, however, urges that the worm is not the cause of the disease, as although in 48 cases he found it present in all but one, yet the numbers were too small to account for the symptoms. Still, it would seem that even a small number of parasites could cause a large anæmia if there be much loss of blood. In the late Burmese war, our troops suffered much from beri-beri, but I have not been able to find any mention as to its relation to intestinal parasites.

In *prevention*, Leuckhart has shown that the mature eggs of the worm, on being discharged from the patient's intestines, undergo their primary stage of development in wet soil, being especially favoured by a high temperature. On reaching the larval stage, the parasite is then taken into the human organism by the drinking-water, where the further stages of its development are gone through. All damp ground in Egypt should therefore, on this as on so many other accounts, be rejected for camps. The water-supply must on this, as on all other accounts, be carefully guarded from all chance of fæcal infection; and, finally, the water on this, as on all other accounts, must be boiled and filtered.

Filaria Sanguinis Hominis.—The occurrence of this parasite, as it would affect British troops, is thus distributed:—O'Neill states that it occurs on the West Coast of Africa. Sonsino has proved its existence in Egypt; whilst the remarkable researches of Manson show how rife it is in China. It appears to be indigenous only in tropical regions. It occurs also in our possessions in the Filaria sanguinis hominis.

Manson's researches. West Indies. Dr. Manson has given us the clearest account of the life-history of the parasite, and, by his admirable work, has completed the whole cycle of its existence. To understand the rational method of prevention, we quote the history of the life of the parasite briefly from Manson, only so far as to enable us to indicate this clearly. The parent worm lies in a lymphatic vessel, and here emits her young into the lymph stream; along this they are carried to the lymph glands; thence, by traversing the parenchyma, they reach the thoracic duct and so the blood. In the blood they exhibit an extraordinary periodicity, appearing in swarms from 8 P.M. to 8 A.M., whilst during the day they are absent from the circulation, and are probably lying at rest in some abdominal or thoracic viscus. This filarial periodicity is, for some unknown reason, an adaptation to the habits of the mosquito, for the latter is the intermediate host of the parasite. Manson's acute ingenuity proved this. The mosquito biting the human host, the embryoes curl round its proboscis, and are then transferred to its stomach. Most of the filariæ are then digested and passed out, but a few undergo development inside its body, when, after her meal, the mosquito retires to some water, and for the next four or five days occupies herself in digesting her meal and in maturing her ova. This process completed, she dies in the water. Meanwhile, the development of the filarial embryoes is completed inside the body of the mosquito. After the death of their intermediate host, they probably bore their way through its dead body, if they have not already escaped, and thus they find themselves in the water, whence they are swallowed haply by man; once in the human stomach, the female bores its way into the lymphatic vessels, finally arriving at its permanent abode in some distant lymphatic radicle or vessel; here it is joined by the male; they breed, and their progeny passes into the blood, there to await for the friendly mosquito, within which it, in turn, will complete its development. Such being the history, *the prevention* of filarial disease is easy. Cover all wells and water-jars in filaria districts with netting, thus keeping out the mosquito. Let the men, as far as possible, sleep under mosquito curtains, or anoint themselves with carbolic oil; and, finally, let all water be boiled and filtered. By any one or all these means, the parasite could be exterminated.

Filaria medinensis. **Filaria Medinensis.**—The filaria medinensis, or guinea-worm, is another parasite of which our troops have had experience. It occurs on the West Coast of Africa, especially on the various districts of the Gold Coast. In Egypt it is not endemic, but was brought thither after the conquest of Sennaar and Kordofan, from contact with negroes. It is endemic in Kordofan and Darfur. In Abyssinia it occurs on the coast. It is also met with in Syria, and in some parts of Turkestan. In the Ashanti war provisions were made against it, also in the Abyssinian war, but no cases appear to have been returned. Probably, however, there were cases of infection, as the worm requires nine or twelve months for its development, and infection would not, therefore,

show itself on the spot, for it is only when the stage of maturity is reached, and the ova are about to be hatched, that symptoms appear. I have also seen the worm in Afghanistan.

As regards its *history*, there has been much controversy how the worm gains entrance into the system, and the most contradictory statements are found. This, of course, is immensely important to determine as regards prevention. For a long time it has been generally accepted that the entrance was through the skin, either by a minute worm passing into a sweat duct, or by a minute embryo coming in contact with a broken surface of skin. The arguments for this view were that it occurred in the feet only in those who walked barefooted, and that it did not occur in persons after they wore shoes; that it occurred only in those who travelled for a long time from place to place; that it occurred in Africa, chiefly in the lower extremities, and in India amongst bheesties, frequently on the back. Finally, that when it occurred in the upper part of the body, it only did so amongst those who habitually slept on the ground. And to show that the parasite did not enter by the drinking-water, Dr. Horton adduces a very important fact, that he had never seen or heard of a case of guinea-worm of the liver.

It was, however, originally held that the parasite entered with the drinking-water, and opinion now is again coming round to this view, especially since Fedschenko has demonstrated in Bokhara that a minute crustacean forms the intermediate host. The embryoes of the guinea-worm perforate the skin of the cyclops, and then acquire their highest stage of larval growth within its body; after which, with their host, they reach the human stomach in the drinking-water. Further, its occurrence on the back of bheesties has been strenuously denied. A third mode of communication is asserted by Horton for some cases—viz., that it is contracted by contact with an individual who is already infected. He thinks this method will account for its occurrence in the scrotum among men who neither wash in muddy ponds nor sleep on the floor.

Opinions being so diverse, it will be best to base our prevention with a view to all sides of the question.

Selection of Troops.—There can be no doubt that danger from importation arises to any nation employing negro soldiers from Africa. In Egypt the parasite was frequently observed after the conquest of Sennaar and Kordofan from importation by the black soldiers brought thence. The disease was quite unknown in Java before African troops had been imported thence from Elmina, and has disappeared again from Java since these military importations have ceased. Again, negroes have imported the disease into the West Indies from the West Coast of Africa; whilst, finally, negro troops imported it into Bombay. Hence, every precaution should be taken where negro troops are employed.

Selection of Season.—As regards season, again, here also we see that the hot and rainy seasons are to be avoided. Hirsch

shows how its prevalence is dependent upon high temperature. For instance, it is only during the hot season in Turkestan that we have the proper filaria season, during which Burns states one-eighth of the population suffer from dracontiasis. Ewart for Mewar, and Morehead for Bombay, have pointed out the same facts. Horton lays more stress on the rainy season as regards the West Coast of Africa, and whereas in India hot and dry weather are particularly favourable, in Africa, Horton states, in similar weather individuals are generally free from it. But there can be no doubt that it is, in all parts of the affected localities, least prevalent in the cool season.

Marching.—The men should never march barefooted in the affected regions, especially where they have to march through water, or on muddy and swampy roads. Again, after marching, let the men be careful to wash their feet and clean their boots. If the latter are left saturated with mud and dirt, the parasite very likely will obtain entrance. Horton states that he has never known careful European officers affected with the disease, although they have lived for several years in places where it is endemic, and believing, as he does, in the theory of infection through the skin, he holds this entirely due to the personal care they took of themselves in this respect.

Camp.—As regards the geology of any locality, several Indian authorities have stated that volcanic rocks are especially the site where it is endemic, and that it never occurs on other formations. Hirsch, from a review of the kinds of rock in which it is endemic in other parts of the world, rightly holds it questionable whether the geological character of the ground has any influence whatever.

But there is one important rule as regards camps, and that is, to warn the men never to sleep on the ground. Clarke, quoted by Hirsch, states that the troops at Cape Coast Castle in 1858, who slept on the ground, suffered much from the disease, whilst after they used beds the cases greatly diminished. Horton indeed affirms that the worm only occurs in the upper part of the body, when the affected individuals sleep on the ground. Mats or blankets are not sufficient to keep the disease off: on the coast of Africa, ample provision would be at hand, probably, for erecting bamboo beds. If not, the men must always sleep on a waterproof. Finally, remembering Horton's views of direct contagion, let not the men lie huddled together at night.

Fatigue duties.

As regards fatigue duties in camp or elsewhere, the men must be cautioned never to work with bare feet. Nathan, quoted by Hirsch, shows how a number of sailors of the English navy, who had never been in any of the endemic seats of the worm previously, contracted the disease after working in the water for a considerable time in the Bay of Skanderoon. Heath, relating an outbreak of dracontiasis amongst the crew of a ship at Bombay, states that the officers were engaged on shore just as much as the crew, and drank the same water, but the crew worked barefooted, whilst their officers wore boots. Again, we have a very significant

fact pointed out by Lorinser and Horton, that the lower extremity is chiefly affected. In Horton's table, out of a total number of worms amounting to 62, no less than 50 occurred in the lower extremity from the thigh to the toe, and of these 46 occurred from the knee, whilst 28 occurred from the ankle to the toe. In Lorinser's tables, of 133 cases, 125 occurred from the thigh to the foot, 80 being in the foot or ankle. Of 210 cases given by Ewart, 193 occurred from the thigh to the foot, 120 being in the foot and ankle; whilst, finally, of 369 cases by Grierson, 335 had the parasite in the lower extremities. The opponents of the theory of infection through the skin, explain this by stating that the lower extremity is the site of election of the parasite; this certainly seems to us something of the nature of begging the question: at any rate, no harm can be done by insisting that in all fatigue duties the men should not go barelegged and barefooted; and that after the duties are over they should scrupulously scrape off all mud and dirt.

It has been stated by Drs. Bruce and Scott that in bheesties the worm occurs frequently in the back where the mussuck has lain in contact with the skin. Morehead and Ewart have, on the contrary, stated this fact to be absolutely without foundation. This is rather hard on Drs. Bruce and Scott, for they state they have seen it. The question is whether this is the commonest site in bheesties, for, if not, the worm may have reached the back by travelling. Now, Bruce and Scott say that in bheesties the part chiefly affected is the back; and as one ounce of positive experience is worth a hundredweight of negative, we hold that this fact proves that the body can be infected *viâ* the skin. In endemic regions, therefore, let the bheesties be warned always to dry their backs as much as possible, and to take their water from the clearest pools, for their own sakes. It would be well to supply them with a piece of waterproof to place between the mussuck and the skin. Bheesties.

Dress.—With regard to dress and uniform, we need only reiterate the remarks made concerning care in cleanliness of the socks, boots, and trousers, and the caution never to go barefooted.

Food.—Inasmuch as there have always been strong advocates for the introduction of the worm into the system by the drinking-water, and since the general opinion of the present day would seem to follow that view, it behoves us to take especial precautions in this light, especially as the guinea-worm would seem to be most prevalent in places where water is scarce, and, consequently, we should have but a limited choice of a source for the drinking supply. The greatest argument that guinea-worm gains entrance into the system arises from those cases where dracontiasis bursts out epidemically. Chisholm, in investigating the disease in Grenada, found it to occur only in those negroes who drank from pools of water partly filled by the tide, and therefore brackish; whereas those who drank rain-water remained exempt. Again, in Secunderabad, an epidemic was confined to two companies of a

regiment who got their water-supply from a particular well. There are similar cases, however, showing the opposite view, as where Europeans and natives have taken their drinking-water from the same source, and yet only the latter have suffered. The only possible way of reconciling these cases is to suppose that both the skin and the alimentary canal can serve as portals for the entrance of the parasite into the system.

Fedschenko has recently shown that the minute aquatic crustacean serves as the intermediary host. The embryoes of the guinea-worm perforate its ventral surface, and then acquire their highest larval development in its body; after which, with it, they are transferred to man's stomach by the drinking-water. This crustacean especially inherits sluggish, stagnant pools, swamps, &c.; whilst other observers have found enormous numbers of embryoes of dracunculi in such waters. Ewart and Carter, again, have pointed out that they were never found in pure water; whilst Ewart also states that those who used pure water were never the subjects of dracontiasis.

Thus, as pure a water as can be obtained must be used; also, let all water in the regions in which guinea-worm abounds be filtered and boiled.

Bathing Parades.—All bathing parades should be forbidden in swampy, muddy waters. If there be no suitable places to bathe in, and the men otherwise would be without ablution, then the less evil must be chosen, and they should be as limited as possible in time, and the men should be directed to dry their feet and legs as carefully as possible.

Dr. Vandyke Carter has pointed out an interesting case with reference to bathing in Bombay. In a certain school the boys were accustomed to bathe in a pond, the sediment of which swarmed with tank worms; out of fifty boys, twenty were attacked with guinea-worm during the year. Now, the boys of other schools in Bombay, bathing elsewhere, were unaffected. Horton draws attention to the danger of washing in stagnant pools, and so disturbing the minute worms from the bottom of the water. He quotes cases from the *Madras Times* given by Mitchell, in which the accession of the disease was dated from officers bathing in tanks.

Conclusion. I have entered thus fully into the subject, for when once the worm has become developed in the system, and is about to produce her young, very destructive local inflammation may arise, entirely incapacitating the individual from duty. In the late Afghan war, I saw cases of guinea-worm in men of the Punjab regiments, in which those affected were for the time entirely lost from the effective strength of the force.

The Chiga.—There is another worm found in West Africa, the chiga, which, by attacking the sole of the foot, and piercing it, leads to the formation of a troublesome ulcer, very slowly healing, and undermining the health of the subject.

Its period of activity is the rainy season.

The prevention, of course, consists in not going barefooted.

Hirudo Tazalla.—In the jungles of the Malay peninsula the land leech abounds, and is very troublesome, especially in damp weather, since it readily attaches itself to the limbs and bodies of travellers, causing small and deep ulcers. **Hirudo tazalla.**

Prevention.—Despite boots and socks, this leech seems capable of attacking man. The Malays rub tobacco-juice over their skins to ward it off. Probably carbolic oil would act as a preventive.

The Pipsee Fly.—During the late Aka expedition, the pipsee fly caused great disability and loss of service. The admission-rate from insect bites was only exceeded by those from ague and bowel affections. The men who suffered most were the frontier police, who were unprovided with boots and putties. To obviate this form of disease, a general order was issued strictly ordering the men to wear their boots and putties at all times during the day. At night it was found these insects did not bite. On the march or out of camp the men were only allowed to take off their boots by permission of the commanding officer; directly they halted they were ordered to put them on again, as the insect preferred sheltered, shady places during the warmer hours of the day. The Akas themselves wore a string of beads fastened below each knee, from which hung a loose cloth as a preventive. **The pipsee fly.**

Prevention.—This has already been indicated. In future expeditions on the north-east frontier, the principal medical officer advised that all the men should wear socks. Officers also should wear gloves in the daytime.

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INDEX.

C

D

E

Q

R

S

T

V

W

Y

Z

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